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VISIT TO THE BORDERS OF CHINESE TARTARY AND TO THE SOURCE OF THE GANGES RIVER.

HAVING had occasion lately to visit the upper portion of the Ganges or Bhágirathi valley, I thought that a short account of that interesting portion of the Himalayas may interest the readers of the "Indian Forester."

After completing the examination of several deodar and box-wood forests situated in the basin of the Jumna river, I crossed over to the Bhágirathi valley by the Anchu and Deara Passes, the elevations of which were found to be 11,650 and 11,790 feet respectively.

The view of the snowy range from those passes is extremely grand, the enormous mountain known by the name of Banderpanch being passed at a distance of about 12 miles only, whilst further to the south-east, the magnificent peaks of the Sirkanta, behind which the Ganges takes its rise, form a most impressive spectacle.

After crossing the second pass we came down what may be called an uncompromising descent of about 5,000 feet in five miles, and encamped at the village of Nargon.

The next day we passed through a box-wood forest situated on the Binsi nalla, which runs into the Bhágirathi, and where we found a quantity of box-wood timber being cut for export to London.

The elevation of this forest was found to be 7,200 feet, with a north-western aspect, and as usual we observed the box trees growing amongst huge metamorphic boulders, with plenty of vegetable mould between, also abundance of moisture in the way of springs.

This species seems to prefer the deepest shade, and as a rule it is always found growing under horse-chestnuts, maples and other broad-leafed trees. The trees in this forest are probably finer than those examined in the valley of the Jumna, often running up to 60 or 70 feet in height with a girth of 4½ feet, and some of the boles being 15 to 20 feet long, free of knots.

The rate of growth is apparently exceedingly slow, and some stumps examined showed as many as 55 annual rings to the inch of radius, but the average seemed to be about 30 rings per inch. The average age of full grown trees in this forest seemed to be about 200 years.

That portion of the Bhágirathi valley comprised between Barahart and Suki villages does not present any features of very striking aspect, and the general appearance very much resembles the upper portions of the Tons and Jumna rivers. It may, however, be observed that the Ganges valley is apparently much better wooded than either of the others, especially the latter, and vast forests of Chir (*Pinus longifolia*) and Ban Oak (*Quercus incana*) exist, whereas some portions of the Jumna valley are comparatively bare owing to the more dense population.

The scenery is, generally speaking, picturesque, and some fine cliffs are passed; also owing to the steep slopes of the hill sides, culturable land is extremely scarce, and in consequence the villages are few and far between.

The journey up the valley was made along a fine forest road constructed about 12 years ago, principally by officers of the Forest Department.

The main river is crossed six times by means of a corresponding number of fine wire rope bridges, varying in span from about 100 to 160 feet, all of which reflect great credit on the officer who constructed them, although some of them are now in a somewhat shaky condition.

The total length of the road is 91 miles, and the cost was three lakhs of rupees including the bridges, whereas the original estimate for the whole work is said to have been put down at the modest sum of Rs. 42,000 only.

The geological formation of this portion of the valley is principally syenite, quartz, hard mica schist and other metamorphic rocks. The vegetation of the lower portion of the valley does not differ materially from that of the Tons and Jumna, except that in addition to the ordinary hill trees and shrubs, the *Cupressus torulosa* is found growing along the banks of the main river between 6,500 and 8,000 feet elevation. It is also a remarkable fact that the Karshu and Moru Oaks (*Q. semicarpifolia* and *dilatata*), are altogether wanting in the upper portion of this valley.

After passing the village of Suki, the appearance of the valley undergoes a most remarkable change, and the fall of the river bed at this place suddenly decreases from about 250 feet in the mile to about 40 feet only. This sudden change is probably due to recent glacial action and to the undoubted presence of two fine lakes at no very distant date.

The first of those apparently commenced about a mile above the Suki village, and extended up the valley for a distance of

about 2½ miles, and the second probably extended from Harsil for a distance of about 4 miles further up.

The formation of those lakes after the disappearance of the glaciers, was probably due to some sudden convulsion of nature, which caused several enormous landslips, which dammed up the valley and thus formed the two lakes referred to.

In course of time, but probably not very long ago, the river cut its way through those obstructions, and the lakes gradually disappeared, leaving this portion of the river in its present meandering condition. About 2 miles above Suki we entered what has recently been constituted a deodar reserved forest under the Tihri-Garhwal lease. This forest extends for a distance of about 14 miles on each bank of the river, with an average breadth of about one mile, but it is to be feared that the designation is somewhat a misnomer, as nearly all kinds of rights and privileges are allowed within the greater portion of the demarcated area.

At a place called Harsil, we put up at a bungalow belonging to the late Mr. Wilson, the well-known timber contractor and shikari.

This building is somewhat of a pretentious appearance, and is built in the native hill style, with any number of holes and corners, the whole structure being surrounded by an extensive walled court-yard, containing stables and outhouses, of all sorts and sizes. The history of the late proprietor, Mr. Wilson, is somewhat interesting, as it is said that 35 or 40 years ago he arrived in the Bhágirathi valley with only Rs. 5 in his pocket and a "brown Bess" over his shoulder, and died a few months ago, leaving a fortune amounting to a considerable number of lakhs of rupees.

The foundation of this substantial fortune is said to have been laid by a free use of the "brown Bess" on the Monál pheasants, large numbers of the skins of which he exported annually to various parts of Europe.

He then took to exporting large quantities of deodar timber to the plains, having, it is stated, in those good old times paid a royalty of only Rs. 1 or 2 per tree to the Rajah of Tihri-Garhwal.

After the greater number of the finest trees situated of course close to the river had been removed, the Forest Department stepped in and leased the forests, but as usual the action seems very much to have resembled the "locking of the stable door when the horse is stolen."

Notwithstanding the leasing of the forest to Government, however Mr. Wilson continued to export timber for the Department for a number of years, and is said to have done the work in a very satisfactory manner. This year the system of selling trees standing has been introduced, and Mr. Wilson purchased 924 first class deodar trees from the Harsil block, at

an average rate of Rs. 15 each, the girth of the trees varying from 6 to 15 feet.

We visited the site of Mr. Wilson's fellings, and found the work to have been done in a careful and economical manner.

All the trees felled were converted into metre-gauge railway sleepers, the sawing having been done principally by Punjabi sawyers, and the timber was floated to the plains during the last rains. The average outturn per tree is said to have been about 65 metre-gauge sleepers, which is rather higher than that obtained in the sleeper operations of the Tons Division, School Circle, N.-W. Provinces, where the average per tree during the last two years is found to be about 62 metre-gauge sleepers.

In the neighbourhood of Mr. Wilson's bungalow we observed a wooden erection, which on closer examination we found to be the good old English stocks, and we were informed that the use of this machine was sometimes resorted to by Mr. Wilson, and was found most effective in putting obstreperous Punjabi sawyers into a proper frame of mind. After making various scientific observations in the neighbourhood of Harsil, we proceeded up the right bank of the river to Jangla.

The geological formation above Harsil consists of very soft friable mica schist, and as no rain had fallen for about three months, and a strong wind was blowing, the consequence was, that we swallowed about as much dust as one generally does during a severe dust storm in the Punjab.

All along this portion of the Bhágirathi valley considerable gaps in the forest are observable, due doubtless to the action of avalanches, the slopes being very steep, and the snow fall on the higher mountains extremely heavy.

We found the growth of deodar in different portions of those forests very variable; in the Harsil block the average age of trees 12 feet in girth appeared to be about 160 years, whereas higher up near Jangla, a tree 6 feet in girth was found to be 207 years' old.

The number of annual rings per inch of radius also varies greatly, and on one stump examined in the Harsil block, rings half an inch broad were observed, whereas in other portions of the forest as many as 25 annual rings per inch of radius were counted.

The stocking of the forest is also extremely variable, and on the moraine of an old glacier in the Harsil block as many as 510 trees, varying from 18 inches to 4 feet in girth, were counted per acre, whereas in other portions of the forest the number of trees per acre did not exceed 10 or 12 at the most. On leaving Jangla we proceeded up the left branch of the Bhágirathi river called the Nilang "nalla," with the object of inspecting the higher Deodar and Pencil Cedar forests.

Finally, we determined to visit Nilang on the borders of Chinese Tartary, the distance from Jangla being stated to be

26 "kos" only, which we afterwards found in this particular case to represent a distance of about 20 miles. Whilst on the subject of "kos," I must not forget to warn travellers to this part of the hills regarding the extreme elasticity of this unit of measurement. In fact we found a "kos" to vary in length at different times in accordance with the frame of mind of even the same individuals, and the only convenient unit it can apparently be compared with, is the somewhat vague Scotch "bittock."

The path up the Nilang valley is of the roughest description imaginable, in some places ascending and descending steps and stairs at an angle of 45 degrees, the steps consisting sometimes of boulders and ends of logs, there winding along the slippery edge of break-neck cliffs, the path as a rule in such places sloping in an outward direction.

The traffic down this valley is considerable, and consists principally in the carriage of salt which comes from some salt lakes said to be situated 12 or 15 days' march beyond Nilang. A considerable quantity of wool is also brought down from Central Asia. The salt is conveyed by means of sheep and goats, the average load carried by each animal being about 10 seers or 20 lbs., and on the return journey the traders bring up rice, wheat, &c., from the fertile valleys of Tihri-Garhwal. On the way up we met immense flocks of sheep and goats loaded with salt, each herd being guarded by three or four formidable Tibetian sheep dogs. All these dogs are armed with strong iron collars, and during the day when not on the march they are generally seen fast asleep, but during the night they are continually on the alert, and two of them are said to be more than a match for any leopard.

We also met a considerable number of Spiti and Tibetian ponies, on their way down to the plains for sale.

The manner in which these nimble animals scramble along the path I have endeavoured to describe, and cross the most shaky bridges, is most remarkable, and we were so struck with their dexterity that we purchased two of the best we could find, the prices paid not exceeding Rs. 160.

Marching in the Nilang valley is most trying on account of the piercingly cold wind, which blows steadily up the valley during the greater part of the day, and in a downward direction during the night and morning.

This phenomenon is probably connected with the action of the sun on the atmosphere immediately over the snowy mountains, which doubtless causes it to rise during the day, the converse taking place during the night.

The downward wind is particularly chilling, and I do not recollect of ever having encountered any breeze so cutting, barring the Polar wind on the east coast of Scotland.

The vegetation of the Nilang valley is very interesting, and

the following are the principal species observed by us—Deodar up to 11,000 feet; Blue Pine *(Pinus excelsa)* up to about 12,000 feet, or 1,000 feet above the deodar; Pencil Cedar *(Juniperus excelsa)* from 9,000 to about 12,000 feet; *Juniperus communis* and *J. recurva* up to the limits of vegetation at about 13,000 feet; Birch *(Betula bhojpattra)* up to 13,000 feet; a small Rhododendron (*R. anthopagon*) up to the limit of vegetation.

Besides the above we found two kinds of honeysuckle, a rose, *Berberis vulgaris*, *Viburnum continifolium*, a gooseberry, *Acer caudatum*, *Spiræa*, a willow, and a kind of broom, most of which are found up to 11,500 feet. Neither Rai nor Morinda (*A. Smithiana* and *Webbiana*) are found in this valley, and all the oaks are entirely wanting. Birds appear to be particularly scarce, the only species observed being eagles, the Himalayan Lammergyer, Chakór (or the red-legged partridge), a small kind of crow, and a few water ousels.

The second day's march having been a short one, we started off in the afternoon to visit a neighbouring glacier observed in a side valley, and the ascent to which seemed to be an easy matter when viewed from below.

After a two hours' climb, however, on arriving near the foot of the glacier, what appeared to be a sloping bank from below, turned out to be a most awkward precipice, the scaling of which, after several unsuccessful attempts, our men utterly refused to undertake.

Under the circumstances, therefore, we were obliged, like the King of the French, who, on a certain memorable occasion climbed a hill with the object of doing battle with his enemies, but was compelled simply to march down again, without having accomplished the object in view.

The following day, however, near Nilang, we were more successful, and ascended the neighbouring glacier to a height of 14,300 feet, the foot of the glacier having been found to be 12,800 feet.

The lower portion of this glacier consists of an immense moraine, the boulders and gravel only being visible on the upper surface, with ice beneath, and a stream of water running out from below, but at the highest point we reached, pure ice only was visible.

Some of the boulders transported by this glacier are enormous, and we observed several measuring at least 1,500 to 2,000 cubic yards.

The ascent was found to be no easy matter, on account of the steep slope and rarified atmosphere, also to the fact that the loose boulders are continually rolling down, the least touch being sufficient to set them in motion.

We found Nilang to be a wretched village, consisting of about 20 houses inhabited by a number of very unwashed Tartars, who

were on the point of migrating down the Bhágirathi valley for the winter.

There being little or no rain in this part of the hills, their principal occupation seems to be in connection with the salt trade from Central Asia, also the cultivation of a few miserable fields, from which by dint of irrigating them with the water flowing from the neighbouring glacier they obtain a summer crop of buck wheat and barley.

Here also we observed some fine Yaks, the altitude being too high, and vegetation too sparse, for the keeping of the ordinary hill cattle.

The scenery of the Nilang valley is on the whole striking, and many magnificent precipices, sometimes having 1,500 to 2,000 feet sheer drop were passed *en route*.

Towards Nilang, however, all tree vegetation disappears, and the hill sides have a very burnt dried up appearance of a brick dust colour. The path past Nilang leads to a place in Chinese Tartary, rejoicing in the name of "Chuprow" or "Chuprung" three days' march further on, and where there is a fort said to be armed with enormous magnets.

The effect of this murderous armament is supposed to be, that when an enemy happens to come within a measurable distance, he suddenly finds his weapons wrenched from his grasp, and is thus expected to be left defenceless, at the mercy of his foes.

Not having had either time nor inclination to penetrate further into those inhospitable Tartar wilds, we retraced our steps down the valley, and after having crossed the Barong Gati bridge, which spans the Nilang nalla near its junction with the Bhágirathi, we proceeded to Gangotri and Gá-í-mukh at the source of the Ganges.

The bridge above referred to is undoubtedly the *chef d'œuvre* of the Bhágirathi bridges, it being 282 feet long, situated at a height of about 300 feet above the river, and the work reflects great credit on Mr. O'Callaghan, Deputy Conservator of Forests, by whom it was constructed about 10 years ago.

Gangotri, besides being a very picturesque spot, is the seat of a famous shrine, which although it cannot boast of much from an architectural point of view, still it is said to be looked upon as the eye of the world by all pious Hindus.

From the river in the immediate vicinity of the temple, the famous "Ganga pani" is obtained, and on the march we met numerous strings of coolies transporting this mild beverage to the plains, where it fetches high prices from devout Hindus, notwithstanding the fact that the original water doubtless becomes considerably diluted with ordinary "Kua páni" or other unholy compounds *en route*.

From Gangotri I proceeded to Gá-í-mukh, or the place where the Ganges is supposed to take its rise.

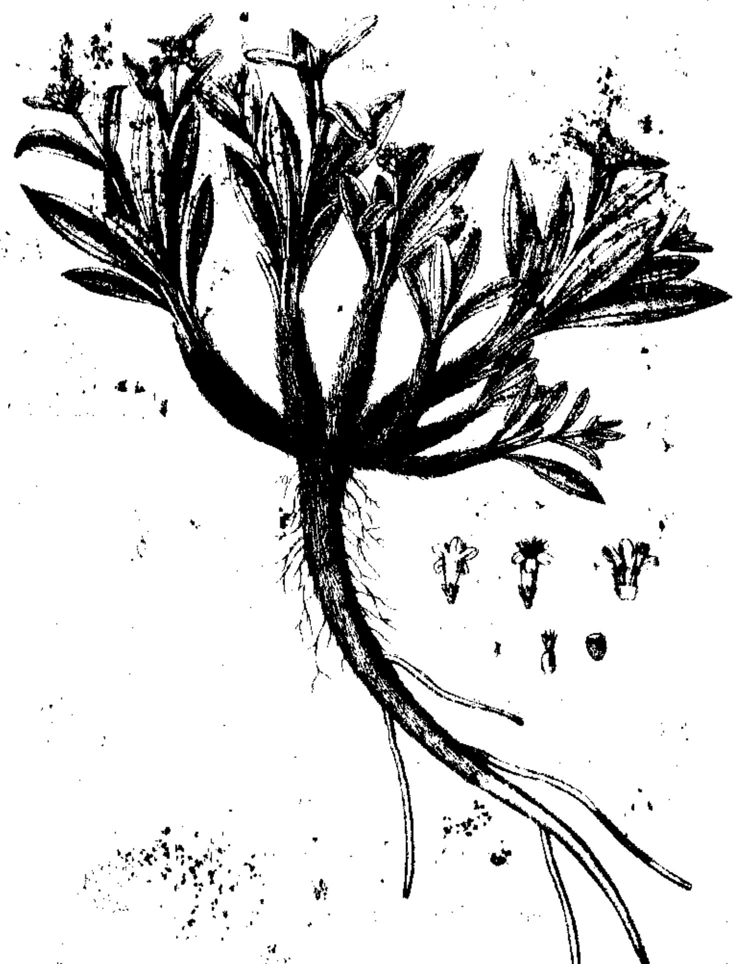
For a distance of about 8 miles along the river bank I observed numerous traps set by the local "shikaris" for a kind of rock martin, common in this part of the hills, and 100 skins of which the Rajah of Tihri-Garhwal is anxious to obtain at the rate of Rs. 3 each, with the object, it is said, of presenting them as a parting gift to a well-known local official, who is about to retire.

On arriving at Gá-í-mukh I found the river issuing from what may be called an ice cave, at the foot of an enormous glacier, probably about 5 miles long and half a mile broad, and here the mighty Ganges consists only of a small stream about 30 feet wide and 1 foot deep.

Having thoroughly explored the lower end of the glacier, and found the altitude to be about 12,800 feet, I proceeded up the hill to the right, on "shikar" intent. After having scrambled about two miles up the hill side, and ascended probably 1,500 feet, the "shikari" who accompanied me, suddenly pointed to the horns of a large animal amongst some boulders in a small ravine. It being impossible to approach nearer without being seen, and not feeling inclined to aim for quarter of an hour like the famous Mr. Briggs on the memorable occasion when he shot his first red deer, I was under the necessity of firing at where I thought the beast's body ought to be, but, as generally happens on such occasions, the result was a miss, and away went two splendid ram Barhal, down the "khud" at a break-neck pace, to the utter disgust of the expectant "shikari." After running about a mile, however, we observed the Barhal come to a halt, so we immediately set about stalking them in as cautious and scientific a manner possible, under the somewhat depressing circumstances. After about an hour's hard work we again came up with the game, when I brought down number one standing, with my right barrel at about 60 yards, and then number two running with my left, at about 150 yards' distance. On examination we found them to be a magnificent pair of old rams with 24 and 23 inch horns respectively, and after having arranged for the bringing in of the game I returned to camp 3 miles further down the valley, very well satisfied on the whole with my visit to Gá-í-mukh.

Whilst touching on the subject of "shikar," I may mention that in the Bhágiráthi valley pheasants of all kinds are apparently conspicuous by their absence, and although accompanied by one or two pretty sharp scenting dogs, we saw only two covies during three weeks we spent in the valley, whilst in the Tons and Jumna valleys we should have seen the same number every two or three hours, and there can be little doubt that the late Mr. Wilson's followers have thinned out the game considerably.

DEODAR.



Nardostachys Jatamansi

NARDOSTACHYS JATAMANSI, THE SPIKENARD OF THE ANCIENTS.

WHEN, some fifty years ago, Dr. Forbes Royle was Superintendent of the Botanical Gardens at Saharanpur, the hillmen of Garhwál were wont to bring down the roots of Nardostachys for sale in the bazars at the foot of the hills. On one occasion Dr. Royle obtained several pounds of the freshly dug root from Nágul, a village situated at the foot of the Himalayas about five miles N. E. of Dehra. These roots were planted partly at Saharanpur, partly at Mussoorie, and one of the former which vegetated during the cold weather is figured on Plate 54 of Dr. Royle's well-known Illustrations of the Botany of the Himalayan Mountains. Another figure on the same Plate (which we reproduce here on a smaller scale) is that of a natural plant from the hills, and is an excellent representation of the plant as it is found in its real habitat.

Nardostachys Jatamansi, DC., which belongs to the natural order of Valerianeæ, grows in the alpine Himalaya at elevations above 11,000 feet, Vedarkanta, Shalma, and Gossainthan being among the localities mentioned by Royle. On the high ridge separating the Jumna valley from that of the Ganges, it is quite common, and has been found by the writer far above the limit of forest vegetation, between 12,000 and 13,000 feet. It is also common throughout Tihri-Garhwál at suitable elevations.

In Dr. Royle's time we are told that "the roots of *Jatamansi*, no doubt the Spikenard of the Ancients, were brought down in large quantities from the Himalayas to the plains, whence they are distributed over every part of India, being highly esteemed as a perfume, and for their uses in medicine." Now-a-days this export has almost ceased, at any rate from Tihri-Garhwál. I was given to understand that the Rájah of that State had imposed a tax on the article, and that it no longer paid for the trouble of digging it up and carrying it many days' march to the bazars and entrepôts along the base of the hills. At the present day the root is chiefly brought to Najibabád in Bijnor, but even there the annual imports do not exceed twenty maunds. From Najibabád, it finds its way to Delhi, Saharanpur, and other places in the north of India. The retail price in Saharanpur and Dehra is about 10 to 12 annas per seer.

This plant is interesting as being of immense antiquity, and the eminent orientalist, Sir William Jones, has satisfactorily proved that the *Nardos* of the Greeks, the *Spikenard* of Holy Writ, the *Jatamansi* of Sanskrit, the *Sumbul* of Persian writers on Materia Medica, and the *Bálchur* of Indian bazars, are one and the same plant.

It has been objected that the fragrance of the Jatamansi is not such as to warrant the probability of its having been highly esteemed by the ancients, but Dr. Royle justly replies that "it

is both incorrect and unphilosophical to infer the tastes of another time and country from those of the age and place we live in. In the instance before us, however disagreeable it may be to some, there is no doubt that the Jatamansi is highly esteemed in the present day throughout the East, both as a perfume, and a stimulant medicine. Indeed, from the number of complaints, enumerated in Persian authors, for which it is said to be a cure, this root might lay claim to the title of a true *panpharmacon;* and with respect to the fragrance, I consider that of the true Jatamansi to be far from disagreeable."

The root, when thoroughly dry, has in my opinion a distinctly pleasant, though rather strong, scent, and I shall be glad to receive any information regarding its value with the European perfumers, and whether it is employed by them in the preparation of any of the numerous perfumes which they offer to the public. It has before now been procured in a chemist's shop in London, and no doubt it is well known to the trade, though there is probably not much export.

A. S.

THE INTERNATIONAL FORESTRY EXHIBITION.

THIS Exhibition, which will be held next year in Edinburgh, is intended to include everything connected with, or illustrative of, the forest products of the world, and will be open to exhibitors from all countries. The Committee will endeavour to obtain from the various British Railway Companies special terms for the conveyance of exhibits to and from the Exhibition. Arrangements will be made for the reception of exhibits at a date to be afterwards fixed. Exhibitors of machinery requiring the use of water, gas, or steam, must state, on making their entries, the quantity of water, gas, or steam which will be required. Medals, money prizes, and diplomas for exhibits and essays will be awarded by competent jurors. Contributors to the Loan Department are requested to communicate with the Secretary, who will supply special forms to be filled up by them. Free space will be given for workmen's approved models. To ensure uniformity of decoration and general effect, no exhibitor will be allowed to put up any sign, flag, banner, or other kind of decoration, without the approval of the Committee. Specimens will be shown of the various kinds of axes used for felling trees, as also of the different descriptions of machines for preparing the timber for constructive purposes. There will also be on view examples of textile fabrics manufactured from bark. The literature of the subject will be illustrated by reports of the Schools of Forestry in all parts of the world. Closely allied to this branch of the subject is the preparation of working plans, showing the age of plantations and the stage of growth at which cutting should be resorted to. By the preparation of

such plans the proprietors of forests are led to take a greater interest in the woods on their estates, and so are enabled the better to direct their management, preventing over-felling in some seasons, guarding against overcrowding at other times, and thus rendering the plantations less liable to the ravages of such a gale as that of October 14, 1881. The Machinery Section ought to be particularly interesting, for it will not only include the usual implements used in the felling and converting of wood generally, but also models of foresters' huts, timber-slips, bridges and weirs, sluices, as well as the machinery employed in the transporting and transplanting of timber. The Loan Collection of the Exhibition will, it is anticipated, prove one of the most attractive of all, including notable specimens of carving, wood engraving, photographs, paintings of famous trees, and also sporting trophies from all parts of the world.

The following list of Patrons, on which Her Majesty has graciously consented to allow her name to be placed, will give some idea of the interest which the enterprise is creating :—

The Marquis of Lothian, President; the Dukes of Buccleuch, Richmond and Gordon, Buckingham and Chandos, Athole, Argyll, Sutherland, Roxburghe, and Grafton; the Marquises of Tweeddale, Huntly, and Stafford; the Earls of Derby, Wemyss, Home, Aberdeen, Kimberley, Stair, Rosebery, Rosslyn, Seafield, Northesk, Moray, Kinnoull, Dalhousie, Galloway, Hopetoun, Mar and Kellie, Selkirk, and a large number of the principal landed proprietors throughout the country.

The Lords of the Committee of Council on Education have been pleased very warmly to commend the project, as likely to foster and encourage the spread of the knowledge of scientific forestry, and Her Majesty's Principal Secretaries of State have accorded to it their hearty recognition and support.

As usual in such undertakings, a Guarantee Fund, which at the present date amounts to nearly £4500, has been started to insure the promoters against loss.

The Executive Committee consists of—The Marquis of Lothian, K.T., President; Sir James Gibson-Craig, Bart., Vice-President; the Lord Provost of Edinburgh; Mr. Hutchison of Carlowrie; Dr. Cleghorn of Stravithie; Professor Archer, Industrial Museum; Mr. Murray, of the "Challenger" Expedition; Mr. Skinner, City Clerk; Mr. F. N. Menzies, Secretary of the Highland Society; Mr. Dunn, Dalkeith Gardens; Mr. Methven, Nurseryman; Mr. Park, Engineer; Mr. Wenley, Bank of Scotland.

Of these gentlemen, Messrs. Hutchison, Menzies, Cleghorn, and Skinner act as Honorary Secretaries; Mr. Wenley as Honorary Treasurer; and Mr. George Cadell, formerly in the Indian Forest Department, has been appointed Secretary.

The following resolution of the Government of India has been circulated to the Local Governments, but as it is dated 21st

December, 1883, it is feared that the notice is too short for Indian Forestry to be properly represented.

"In recommending to Local Governments and Administrations participation in the representation of India at the Exhibition in question, His Excellency the Governor General in Council trusts that, although the time available for preparation is so limited, every endeavour will be made by the provincial Conservators of Forests to expedite the preparation of a suitable collection of exhibits, which should be despatched direct to Edinburgh so as to arrive there on or before the 1st April next, the instructions on this subject contained in the papers cited in the preamble being carefully observed. No attempt need be made to get up a general collection of woods for the Exhibition, as it is proposed to send an Index Collection from Calcutta; but specially fine pieces of the most valuable species of timber in each province, which it is desirable to bring to notice, should be sent to the Exhibition. It will be useful if local Conservators would consult the *Inspector General of Forests regarding the details of the collections* to be sent.

"A representative set of Forest Maps will at the same time be prepared for the Exhibition by the Superintendent of Forest Surveys, accompanied by a list of the Maps.

"A report should be furnished to this Department of the action taken on these suggestions, simultaneously with the transmission of the exhibits to Edinburgh."

NOTE ON USES OF *PINUS EXCELSA*.

Pinus excelsa wood is useful for a great many purposes, and I chiefly purchase it for plane tables and patterns for the Foundry. Some parts of gymnastic apparatus are also made from it, and levelling staves. You will find in Stewart's Punjab Plants, under *Pinus excelsa*, that "Mr. Watson told him that it is the best of all for pattern-making because it works well, and is non-resinous," and Dr. Stewart thinks he must have got hold of some other common wood or picked specimens, as the *Pinus excelsa* is, he states, very resinous. Mr. Watson is right and Dr. Stewart wrong, and I can endorse what Mr. Watson states.

In former years we used great quantities of *Pinus excelsa* for soldiers' cot planks, but it was impossible to please those who had the passing of the planks, as knots and the slightest crack caused a plank to be condemned. Then the Commissariat Department got teak planks from Burma, these were split also, but as they had been bought and could not be condemned, the ends were rivetted up and the planks used.

It may interest you to know that before the days of ice machines in India, the ice ships from America used to bring out a good deal of pine wood; it was something like the *Pinus excelsa*, but free from knots, and this wood actually cost us less than the *Pinus excelsa* grown on hills that we could see from Roorkee.

A. C.

II. Review.

REPORT ON THE FORESTS OF CEYLON.

By F. D'A. Vincent, *Deputy Conservator of Forests, Madras.*

It has become quite customary for the British Colonies to indent on India when they wish for special reports and advice as to the administration of their forests, and we may instance Major Campbell Walker's work in New Zealand, Mr. Thompson's in Mauritius, Mr. Hutchins' in the Cape, Mr. Dobbs and Mr. Wild's in Cyprus, and now again Mr. Vincent's in Ceylon.

Mr. Vincent's report is very exhaustive, and though it might with advantage have been more condensed, and instead of giving the Burmah Forest Act as an Appendix, he might have drawn up some outlines of an Act specially adapted for Ceylon, yet we have found it extremely interesting, and very much to the point in its practical suggestions.

Ceylon contains 24,702 square miles, being about one-third of the North-West Provinces in area, and its population is about 2¾ millions. It is divided into seven provinces, corresponding to districts in India, each under a Government Agent, who differs from Indian District Officers in having no judicial work, and only exceptionally judicial power.

Rather less than one-sixth of the Island is under cultivation, the only permanent grain crop being paddy, and the other grain crops being grown on *cheena* or *jhúm* clearings or in gardens.

On paddy lands Government claims one-tenth of the crop, but in *cheena* crops the practice varies, in some places *cheenas* being free, in others subject to a tax of one-fourth to one-fifth of the crop when licensed, and of double this when unlicensed, and in these *cheenas* the crops are classified as dry grains, millets, hill-paddy and maize which are taxed, and tobacco, chillies, cassáva, plantains, pumpkins, &c., which are always free. It would appear, as Mr. Vincent remarks, that *cheena* cultivation is more heavily taxed than permanent paddy lands, but in the latter case the return seldom exceeds 15-fold, and the cultivation is expensive and laborious, whereas in *cheenas* the minimum of labor is involved with a return, at the lowest estimate, of 40- to 60-fold.

There is no other land-tax, but we will give Mr. Vincent's own remarks in the next few paragraphs.

"There is no other land tax, so that we have the anomaly of the principal food grains of the people being heavily taxed with a Government demand of 10 to 25 per cent., whilst all the land cultivated with tobacco, plantains, or so-called garden produce, also that covered with coffee, tea, cinchona, and likewise the large areas planted with cocoanuts, cinnamon, and citronella grass, belonging chiefly to natives, is held free of all taxes. We shall also see further on that paddy, the best food for the people, is taxed more heavily than the 'dry grains,' which are said to be very heating and unwholesome.* The only other direct tax is a poll-tax of Re. 1½ to Rs. 2 a head, paid annually by all males towards the construction of roads.

"European enterprise has employed itself almost entirely with coffee, cinchona, tea, cocoa, Liberian coffee, and in a small way with cocoanuts. Cinchona, tea, cocoa, and Liberian coffee are known as new products, in contra-distinction to coffee, which is the old staple Ceylon product.

"Coffee grows best at elevations between 2,000 feet and 5,000 feet, with a rainfall of over 80 inches. Owing to the ravages of *Hemileia vastatrix*, a fungus causing the malady known as the leaf disease, the exports of coffee have decreased from 824,509 cwts.† in 1878-79, to 564,000 cwts. in 1881-82. Ceylon coffee still fetches the highest price in the London market, but a serious fall in the market price from 100*s.* per cwt. to 70*s.*, adds still further to the difficulties of the situation. Liberian coffee is largely cultivated in the low hilly country between the western coast and the mountain ranges, but the exports, which have not yet assumed any large dimensions, are included with Arabian coffee in the figures given above.

"Cinchona grows at the same elevation as coffee, and up as high as 6,000 feet. The exports are as yet comparatively small, but in a few years, when all the trees planted out in the old coffee estates have grown up, the annual production will become very large. Already Ceylon exports one-fifth of the total amount of cinchona bark imported into Great Britain. Tea and cocoa also promise to play an important part in the future trade of Ceylon.

"The exports of these three products have increased very largely in the last few years, as the following figures will show:—

Exports.

	1879.	1882.
Cinchona, ...	lbs. 1,200,000 ...	lbs. 3,099,000
Tea, ...	„ 103,000 ...	„ 623,000
Cocoa, ...	cwts. 122 ...	cwts. 1,018

"The other principal exports of Ceylon are cinnamon, cocoanut oil and coir, citronella oil, &c."

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* Ceylon has to import rice and paddy: over 7 million bushels were imported in 1881. Taking the Blue Book figures, showing 550,000 acres under paddy, with a yield of (say) 20 bushels an acre, the Island's production in 1881 was 11 million bushels.

† These and the following figures are taken from the Chamber of Commerce Return of October 1882.

The revenue of the island in 1881 was Rs. 1,36,86,491, being slightly in excess of the expenditure, and is derived principally from import duties on rice and cotton goods, *sales of Crown lands*, land revenue, salt and timber sales, &c.

There are excellent metalled roads kept up throughout the year, and the removal of timber is easy, and carriage cheap and abundant.

"Circumstances generally in Ceylon are very favorable for timber transport, especially in the dry zone. The streams are too small, the woods too heavy for floating; but the Island is here not more than 120 miles across, and the best forest often grows close to the sea-shore. The country is very level, the streams are dry for 9 months in the year, and a rough but serviceable cart-track can be made by cutting away the jungle. Cart hire is cheap, and the expert Malay and Tamil timber cutters have always been accustomed to heavy timber work. The forests, too, are unusually healthy nearly all the year round—no unimportant consideration."

There is a railway from Colombo to Kandy, and two branches, the total length being about 100 miles, and extensions are projected. Regarding the physical features of the country, we will again quote from the Report.

Topographical Features.

"The principal feature of the Island is a high central tableland equidistant from the eastern and western coasts. Rising suddenly *from the low-lying country* to the north, east, and south, and from the low hills along the western coast to a height of over 6,000 feet, it forms a very remarkable feature when approaching the Island by sea, from which Adam's Peak, over 7,000 feet elevation, is only 42 miles in a direct line. This tableland is enclosed by a range of lofty hills, rising very suddenly from the plains or low country, to an average elevation of 3,000 to 4,000 feet. Forming three sides of a square of about 50 miles, it encloses the central plateau on all sides except to the north, where, through the scattered hills of Mátalé, Hunnasgiriya and the Knuckles, the Mahaviliganga, draining nearly the whole of the plateau, finds an outlet. The peaks rise to an extreme *height of 7,352 feet at Adam's Peak, and 6,664 feet* at Namunakuli, forming the south-west and east corners of the range.

"Between the plateau and the seaboard to the west and south-west, the country is hilly and undulating. There are a few outlying spurs, off-shoots of the main ranges, rising to an height of about 2,000 feet. Except quite close to the sea, the general character of the country consists of broad deep valleys, separated by steep and rocky, though forest-covered, ridges. This hilly country coincides with the damper portions of the Island. To the south, east and north of the central mountain system, the country, from the foot of the hills down to the seashore, consists of level forest-covered plains slightly raised above sea level, the only natural features to vary the monotonous scenery being a few rocky gneiss hills.

"In the centre of the plateau dividing it into two halves we have

the highest range of the Island, with several large side spurs, running north-north-west for nearly 40 miles. The average height of this range is about 6,000 feet, the highest points—Pedro and Kirigalpotta—having respectively an elevation of 8,296 and 7,831 feet.

"To the western side of this dividing range we have what was originally all forest-covered country extending down to the edge of the low country and onwards to the sea. The country is hilly and irregular; the temperature is high and equable; the rainfall heavy and frequent, and the air always heavily charged with moisture. The vegetation is characteristic and tropical, very similar to that of the west coast of Travancore and to other tropical islands, but it is here that most of the species peculiar to Ceylon are found. Of the forest, large areas have been cleared for coffee and for cheena cultivation.

"To the eastern side of the main range we have a drier country extending for 80 miles down to the Bay of Bengal. On the plateau, for about 25 miles in the Badulla and Passara direction, there are grassy downs or patanas. The ridges are covered with grass, with patches of forest in the hollows and on cool protected slopes. The tree vegetation has less of a tropical character, and the growth shows less vigour. On the western side of the plateau the hills are very steep and the valleys deep; here the difference in elevation, between the tops of the hills and the valleys, is much less—we have long flat ridges and shallower valleys, and the country has a more undulating character. The eastern side of the plateau is protected by the main range from the summer monsoon rains, and resembling the corresponding slopes of the Nilgiris, consists of very similar grassy downs, with 'sholas' in the valleys and in protected situations only.

"The western and eastern hill slopes and the country between the hills and the western coast comprise the *Moist Zone.*

"Once off the plateau and in the so-called low country, the patanas disappear, and—occupying about three-fourths of the entire Island—*we have a level country, nowhere much raised above sea level,* with a moderate rainfall and a well defined period of hot dry weather, which is covered down to the seashore with a peculiar and most characteristic class of forest. The only natural features of any interest are the large isolated hills, apparently outliers of the main mountain system, consisting of enormous masses of gneiss rock. The largest of these are Friar's Hood, 2,134 feet; Gunner's Quoin, 1,766 feet; False Hood, 2,394 feet; and Westminster Abbey, well known landmarks for ships passing along the eastern coast. There is little variety except that the further north we go, leaving the main hill ranges behind, the rarer become these clusters of rocky hills, and the greater the similarity, both in physical characters and in vegetation, to the opposite Indian coast. North of Vilánkulam, for 60 miles up to Elephant Pass, there is an unbroken stretch of level forest-covered plains from sea to sea. The rainfall rarely exceeds 40 inches, and, instead of luxuriant tropical growth, we have forest of rather a stunted character. The trees, slow-growing and small, both in girth and height, often deserve the name of scrub instead of forest; they struggle on, nourished more by the humid atmosphere and the frequent rainfall than by the poor sandy soil.

"This part of the Island is elsewhere spoken of as the *Dry Zone.*

"The principal rivers and all those with a permanent flow of water take their rise from the central hill ranges. The Mahaweliganga, the largest Ceylon river, drains both sides of the central plateau, the drainage of the western slopes being carried by it past Kandy, to unite where it leaves the hill country with the Badulla or Uva branch. It runs through the important forest country of Bintenna and Tamankaduwa, into the sea near Trincomalee on the eastern coast.

"With the exception of the Kelani-ganga, which rises on the north side of Adam's Peak, all the other rivers rise on the outer slopes of the range flanking the central plateau. The most important streams are the Deduru-oya, Maha-oya, Kalu-ganga, Gindura, Nilwalá-oya, Walawé-ganga. Except for more than 20 miles from the sea, these are generally suitable for floating purposes in flood time only. Within that distance the Kelani and the Kalugangas, whose *embouchures* are at Colombo and Kalutara, and the Gindura, in the Southern Province, form fine navigable streams, on which large quantities of the lighter kinds of timber and of firewood are brought down in rafts and boats by native traders. Few of the rivers draining the drier country, even though they have their sources in the central mountains, have any permanent flow of water; of many, the beds are quite dry for nine months in the year, and the chance of floods, high enough for floating purposes, is somewhat uncertain at all times."

We will not follow Mr. Vincent in his account of the geology of the Island, but simply note that the rocks are generally sedimentary, but of uncertain age, without any fossil remains, the mountain ranges and isolated rocks being of gneiss.

It can also be conclusively asserted that the land is gradually rising, especially along the western side of the Island.

Mr. Vincent characterises the soil as mostly inferior, the superficial soil consists generally of sand, or a red sandy or gravelly loam, sometimes passing off into a red clay, and overlying deep gravel beds, in which so little nourishment is obtainable that all trees throw out large lateral roots.

In the dry zone there is no humus, but large deposits of leaf mould are found in the hills and damper zone, where there is a good rich surface soil.

Mr. Vincent considers this as very curious, as the forests are all evergreen, but the dead leaves rapidly decompose in the dry zone. Owing to this want of humus, there is no certain reproduction by seed of the slower growing and more tender species.

For an account of the meteorology, we will again quote from the report.

"The climate of Ceylon is most equable, especially along the western coast, where the daily mean temperature varies little all the year round.

"The annual mean temperature for the whole of the low country is much the same, the greatest difference being 2° to 3° between Galle and Jaffna, at the southern and northern extremities of the Island.

The rainfall and annual mean temperature of those places are respectively—Galle, 90 inches, 79·9°; Jaffna, 42 inches, 82·2°. There is, however, considerable difference in the daily and monthly mean temperature in different parts of the Island. Where the low country is affected by the south-west monsoon rains, the daily range of the thermometer is never greater than 12 degrees, the air is always saturated with moisture, and there is no real cold weather. The coolest time of the year is from May to October, as during those months the showers are frequent and the sea breeze is steady. The hottest months are February, March, and April.

"In the drier parts of the Island the daily range of the thermometer is large, being as much as 20° in some places. From October to March is the coolest time of the year, but as soon as the monsoon changes and south-westerly currents begin, the country dries up and the weather gets hot. The south-west monsoon makes itself felt in the dry zone, comprising three-fourths of the Island, as a hot land-wind, parching the grass and the leaves.

"In the Eastern Province it comes direct from the central ranges of hills, and having been there relieved of much of its moisture, gets well heated in passing over 100 miles of dry country before reaching Batticaloa or Trincomalee. In the Hambantota District and from Puttalam northwards, as indeed throughout the dry zone, although coming direct from the sea and laden with moisture, it brings no rain; all the tanks on which the people depend for drinking water dry up, and forest work becomes very difficult in many parts of the country from July up to the burst of the north-east monsoon in October.

"It is probably in great measure due to this hot wind blowing for six months in the year that the growth of the forest in the dry zone is so stunted and poor. A rainfall of over 40 inches in an atmosphere so equable and so nearly saturated with moisture is sufficient for good forest growth if a gale of wind did not blow continually for six months and dry up the soil.

"The influence of the rainfall and its distribution on the vegetation is more remarkable in Ceylon than, perhaps, anywhere else, for probably in no other part of the world are the limits of a moist zone, of heavy and light rainfall, so sharply defined by the natural tree vegetation. In parts of Bombay and Madras we may find locally some partiality in the rainfall as in Ceylon, but nowhere is the south-west monsoon so localized in its influence, and so regular in the area of its distribution, year after year.

"There is, as far as I am aware, no account published of the meteorological phenomena of Ceylon, and the science has scarcely received the same attention paid to it in other countries. Rainfall records are published by the Surveyor-General and the Public Works Department. The former has arranged 14 observing stations in different parts of the Island, where full observations have been taken for the last 10 to 12 years by paid observers. In addition to this, 50 rain gauges have been placed in different parts of the planting districts, where rainfall records are kept up. Only the rainfall returns have as yet been published, although I understand the full results of ten years' observations will soon appear in print.

"The Public Works Department return comprises 62 stations in different parts of the Island, where records are kept by overseers and tank guardians. Between this return and that mentioned above there are very great discrepancies, and as, from the position of many of the Public Works Department rain gauges, there is every reason for questioning the accuracy of the figures published, I shall only notice those published by the Surveyor-General.

"Ceylon lies directly in the path of the south-west and north-east monsoon currents, and almost all the rain clouds which empty themselves on the Island come from these directions. The only exceptions are a few thunder clouds which hang about the Island during the short period of still weather—between the close of one monsoon and the commencement of the reverse current. The south-west monsoon commences about the beginning of April, increasing in force till it reaches its height, about the middle of May. From the beginning of the month the S. W. currents daily increase in regularity and force, but usually not till the end of the month is there any steady wind from that direction on the sea coast, although in the hills the change of season makes itself felt much earlier. It is then said to burst when a succession of heavy squalls of wind and rain comes up from the sea-ward, but the average rainfall of the month of May is not much heavier than in the preceding or following months. In the hills the monsoon downpour begins much earlier than at sea level, but the burst of the monsoon is by no means so marked a phenomenon as on the west coast of India. From a series of dates for 28 years compiled in the Ceylon Directory, it appears that the small monsoon generally breaks in the latter half of April, followed four weeks later by the big monsoon.

"The rain generally clears off about the middle of August on the sea coast, but the wind lasts till the end of September, when the north-easterly currents generally commence. Towards the 15th of October their full force is felt, and a heavy downpour of rain commences and lasts generally 2½ to 3 months. The heavy rain ceases towards the end of January. On the western side of the Island the north-east monsoon wind comes from the north, and is known as the 'long-shore' wind.

"It has already been mentioned that the Central Province consists of a series of hilly ranges, which, rising from 6,000 to 8,000 feet above the sea, have a general direction from north-west to south-east at right angles to the two monsoon currents. The effect of these hills in controlling the rainfall, especially that brought by the south-west monsoon in the summer months, is very marked. Whilst the western slopes of the hills from May to September are in perpetual cloud, the eastern slopes of the central plateau are in sunshine. From the sea upwards, until we cross the highest range, there is nothing but cloud and heavy rain. Nuwara Eliya—the sanitarium, at 6,234 feet—is for months in the clouds and mist, but immediately we get on to the eastern slopes of Wilson's Bungalow, and into the eastern patana country of Uva, the rain and clouds disappear, and the country is perfectly dry. As the clouds from the westward are seen to top the ridge they descend a little, and, being quickly absorbed by the hot dry air, pass on eastwards until they are again condensed on the hills

of Bengal and Burmah. The eastern half of the central plateau gets only an occasional shower, and the leeside of the Island is likewise protected during these months.

"Immediately we get away from the influence of the hills 40 miles north of Colombo, out of the limits of what I have laid down as the moist zone, where the wind can sweep across the Island without being forced upwards by mountain ranges into a colder zone, we get no rainfall beyond an occasional shower during the whole time the south-west monsoon is blowing. It is the same in the extreme south-east corner of the Island, where the annual average rainfall of Hambantota, fully open to both monsoons, is but 37 inches, and the extremities of the Island may be said to be identically situated as regards rainfall. The south-west monsoon, affecting so small a portion of the Island, is therefore of less importance generally than the winter monsoon from the north-east.

"The only area which gets more than one-third of its rainfall or any large quantity of rain from the south-west, is that bounded on the east by the central or highest mountain range running from Kandy to Nuwara Eliya and the Horton Plains. On the north and south this area may be defined by parallel lines drawn south-west from the hills near Nálanda, and from the southern extremity of the Morawak Kóralé. Within this zone, the total annual rainfall is generally over 80 inches. On the sea coast near Colombo and Galle about half of the total annual rainfall comes in the south-west monsoon, but with increased proximity to the hills, as at Kalutara and at Ratnapura, both the rainfall and the portion of it falling in the summer months increase considerably. Ratnapura is 10 miles south-west of Adam's Peak, and this district, with Ambagamuwa and Maskeliya north-east of Adam's Peak at an elevation of 4,000 feet, are the wettest in the Island, having an annual rainfall of 120 to 200 inches. A few miles further into the hills and we get to valleys such as Dimbula and Lindula, protected to some extent on all sides, but backed by higher ranges to the east than to the west. Here the rainfall again sinks to 100 inches, of which two-thirds fall in the south-west monsoon.

"The south-west monsoon is popularly supposed to be that which brings Ceylon most of its annual rainfall; but this impression appears erroneous. On the assumption that the south-west monsoon begins in April and lasts to the end of September, the table annexed has been compiled.* From this it will be seen that the area receiving more than half of its annual rainfall from the south-westerly currents is very restricted. It also appears that the winter rains are much more general throughout the Island, whilst the number of rainy days is less in proportion to the rainfall in the south-west than in the north-east monsoon.

"In the north-east monsoon the currents are of less velocity, and although here, too, the mountains give a somewhat heavier rainfall to the eastern coast, their influence is much less than with the other monsoon, nor they do not afford much protection to the parts on their leeward side. The clouds hang about the land and are condensed generally over the whole Island.

* We regret that we have not space for this table.

"The differences in the distribution of the monsoon rains are in great measure due to the fact that in the summer the land is heated and the temperature is higher than that of the moisture-laden south-west wind. In the winter there is a fall in the general temperature of the land, due to increased radiation without a corresponding fall in the temperature of the sea, and the damp warm winds from the *Bay of Bengal hang over the land, parting with* a great part of their moisture. In the early winter most of the rain falls at night, which is accounted for by the rapid radiation from the soil; but as the season advances the soil gradually gets sufficiently cool to induce the atmosphere to part with some of its moisture during the day.

"It will therefore be seen—

(1). That the principal annual rainfall of Ceylon is due to the north-east monsoon, and that these winter rains are distributed over the whole of the Island, the downpour being proportionately heavier than in the south-west monsoon.

(2). That the area affected by the south-west monsoon is very *limited, and is strictly confined to the country to the south-*west of the dividing mountain range, no rain falling where there are no hills in the centre of the Island to force the moisture-laden clouds upwards to a colder elevation, or to lead to a condensation of watery vapour by increased pressure.

(3). That whilst on the western coast the rainfall increases with proximity to the mountains, the stations on the eastern coast have the same rainfall as those close to the hills. Again, some of the former, such as Trincomalee, have a higher rainfall than an inland station such as Anurádhapura.

(4). Again, at high elevations on the western slopes of the hill plateau the rainfall is generally less than that at lower elevations, whilst on the eastern slopes the rainfall increases with the elevation.

(5). That places like Anurádhapura, in the centre of forest-covered plains, have a much heavier rainfall than narrow strips of land close to the sea—such as Mannár, Jaffna, and Hambantota."

With reference to its meteorology, Mr. Vincent divides the Island as follows:—

The Moist Zone
- (*a*). *The Wet Zone*—comprising the western slopes of the hills and the country south-west of them; also, notably, the region of the special endemic flora. Rainfall 100 to 200 inches.
- (*b*). *The Moist Zone Proper*—comprising a narrow belt surrounding the last; also Uva, or the eastern hill slopes. Rainfall over 60 and under 100 inches.

The Dry Zone—comprising the rest of the Island. Rainfall over *33 and under 60 inches. This includes the* Arid Zone and the Dry Zone Proper. The limits of the former, with a rainfall of 33 to 45

inches, are, in the absence of more extended rainfall observations, difficult to define; it comprises most of the Northern Province and the Hambantota District.

"There are several points which can only be solved when many of the now uninhabited parts of the Island are opened out and the observing stations can be more equally distributed. It will then be interesting to trace the limits of the minimum rainfall zones in the north-west and south-east corners, and the cause of the frequent drought in the latter. In conclusion, it should be noted that Ceylon is out of the region of cyclones."

Regarding the forest growth, we are told that more than 1,000 years ago Ceylon was inhabited by a large and powerful nation, the remains of which, in the form of embankments, temples, palaces, &c., are common in the forests. Mr. Vincent therefore supposes that a large proportion of the existing forests usually described as virgin, or original, are really a secondary growth which has sprung up on the disappearance of the former large population, probably between the eighth and thirteenth centuries of our era. We quote as follows :—

"Speaking generally, the forests may be said to be very patchy; on the hills only are they at all regular. Going along the village paths, (which offered the only means I had for judging of the forest distribution,) the path for half a mile passes through a fairly tall forest with satinwood, ebony and milla; then for one mile it goes through a low forest in which *Hemicyclia sepiaria* (*véré*) is the principal tree, with perhaps *only a few* of the other unsaleable woods; then we pass through cheenas of various ages, and finally reach the paddy land and the village. The same alternations occur everywhere. The villages are equally scattered over the whole Province, except on a broad strip on either side of the Trincomalee road, and also in portions of the Wilachi Kóralé. Each village has its tank, its paddy land, its cheena surrounded by forests, and each becomes a centre round which the destruction of forest gradually progresses.

"If this process has been going on for several centuries, and went on when this part of the country was thickly inhabited, the patchy nature of the forest is fully explained. *The best satinwood, ebony and halmilla forest*, such as we find on the hills, has probably not been cleared for many centuries, if ever; that where there are *satinwood mixed with véré* has been cleared more recently; whilst that *without any satinwood and only the inferior woods, véré especially*, may have been cleared in the last 200 to 300 years. Many other causes have of course been at work, and although there are many arguments against this explanation, these three distinct gradations undoubtedly exist, which cannot be traced to differences of soil and climate. As an instance confirming this suggested explanation, I may mention the forests near Yapahu in the North-Western Province.

"So great are the variations in growth, and so little do the present officers know of the distribution of the forests or of their contents, that it is most difficult to generalise from the little I was able to see here. As has been mentioned more than once, there are still large

areas unexplored. The statements of the Foresters having so often proved incorrect when I had opportunities for investigating, I must respectfully decline to put the least reliance on them. I was shown as the best forests those that appeared to me worked out, and curiously the felling contractors also subsequently made that the reason for declining to cut there. The argument in favour of there being forests and much mature timber left in the unexplored parts is but a negative one. As on the large areas still unexplored, we know that the soil and climate, &c., are the same as in those parts from which fine timber has been cut, it appears probable that the resources of the North-Central Province forests are large."

The best trees are the satinwood (*Chloroxylon Swietenia*), the ebony (*Diospyros Ebenum*), and the halmilla (*Berrya Ammonilla*), but these being slow growing are unable to make head against the more rapid growth of véré (*Hemicyclia sepiaria*) and other worthless trees.

We again quote from the report—

"At the time of the capitulation of Colombo, in 1796, it is probable that the whole of the Island must have been well covered with forest, the present large towns being insignificant hamlets. Kandy itself was only a small collection of huts round the palace of the King, whilst the more thickly inhabited parts of the Central Province and the south-western corner of the Island must have been much like the North-Central Province at the present day—the villages some miles apart, and connected only by narrow foot-paths. The Portuguese and Dutch only succeeded in maintaining coast settlements, and made no advance into the interior.

"The Kandyan Kings adopted, as the most effectual means of defence, the maintenance of a dense belt of forest, 30 to 40 miles broad, all round the Kandyan or Central hill country. This forest was carefully protected, and in the attempts of the Dutch and British to seize the Kandyan country, traversing the forest belt, and subsequently keeping up communications with the seaboard, constituted always the real difficulty. This belt of forest, which protected the Kandyans so effectually, is no longer traceable, and the area occupied by it is now remarkable for the worst devastations of the cheena cultivator.

"Under the Dutch, all private enterprise was discouraged, and it was not till 1833, after the whole of the country had been pacified by British rule, and the Kandyan power destroyed, that any great progress was made in coffee planting. Up to that time the material condition of the people had probably changed but little, although the cheena cultivator and others, benefiting by the absence of an organised Government, and easy taxation, had commenced to make inroads on the forests."

Regarding the extent of the Crown lands in the Island, we learn that no exact data are available, "as the triangulation of the Island has not yet been completed, and the existing maps are not only incomplete, but misleading.

"Fraser's map, on a scale of 4 miles = 1 inch, is most inaccurate. Provincial boundaries are 15 miles out; roads and tanks are out of

position; villages appear that have not existed during the present century; and rivers are made to run in entirely wrong directions. The map has, on the other hand, a most finished and accurate appearance, which is most deceptive, and quite different to the character of the information it supplies."

This absence of proper maps must have impeded Mr. Vincent's inspection of the forests considerably, and a good survey of Ceylon is essential before any idea of the forest area at the disposal of Government can be arrived at.

In the absence of good maps, Mr. Vincent has based his area statement of the forests on the quantity of Crown land which has been alienated, which he estimates to be about 6,840 square miles, or about quarter of the Island, the greater part of the remaining three-fourths belonging to the Crown. But in the hilly and damper portions of the Island, where the estates owned by Europeans are principally situated, it is probable that only a quarter of the area is still Crown land, whilst in the drier parts four-tenths of the country is still unalienated.

The proportion of cultivated and uncultivated land can only be roughly estimated, and is given as follows :—

	Cultivated land, square miles.	Uncultivated land, square miles.	Total, square miles.
Moist zone, ...	2,500	6,200	8,700
Dry zone, ...	1,440	14,560	16,000
Total, ...	3,940	20,760	24,700

We give Mr. Vincent's own words regarding the proportion of the uncultivated land which is forest-clad :—

"To determine what part of the uncultivated Crown lands is covered with forest is difficult. Originally, when the country was opened up by the British, *it is probable that the greater part of the Island was* covered with good timber forests, the following being the principal areas not so covered. In the Northern Province, and throughout the rest of the dry zone, within two to five miles of the sea, there is a good deal of open bush country—not unlike the Punjab Rakhs—with clumps of rather stunted bushes and thorny trees, separated by large open stretches of grass. On the north and west sides of the Island, as far south as Puttalam, and in the south-east corner of the Island, the country within two to five miles of the sea (or even twelve miles in the Hambantota district) is chiefly of this character; not continuous, being often broken in places by good forest going down to the sea-beach, or separated from the sea by a strip of forest one to two miles broad.

"On the eastern side of the Island is the so-called Park Country

(Nilgalla-paláta), of a park-like character, the trees standing singly or in clumps in fine open stretches of grazing land. In the North-Central Province, especially towards Minéri, Pollonáruwa, and in Tamankaduwa, there is a good deal of low land, often with sour black soil, on which only a few Palé, *Acacia leucophlœa*, *Bauhinia tomentosa*, *Cassia marginata*, &c., grow. Finally, in the hills, there are at all elevations the patanas or downs, covered with coarse grass or a few *Careya arborea*, Rhododendron, &c.

"These may be said to constitute the chief exceptions to the rule—that the whole of Ceylon was at one time covered with forest. For these, for the large areas of natural scrub forest in some parts of the Island, and also for the areas of village tanks, roads, rivers, &c., we may make a liberal allowance of four million acres, or one-fourth the area of the Island, and then half the area (8 million acres) is left, on which the absence of forest is not explained by any natural causes. In a climate so favourable that forest will grow on the worse soils, probably the whole of this area would be covered with good timber but for one cause—cheena cultivation."

The account of cheena cultivation which follows is very interesting, resembling the jhúms in the Garo hills, though there the principal staple is cotton as well as hill paddy :—

"Cheena is the Ceylon form of the Indian kumri or jhum, and the Burmese toungya, and as in those countries, it is a favourite means of earning a livelihood. It is so well known, that it scarcely needs any description. The cultivator goes into the virgin forest and fells all but the largest trees. Having allowed the wood and branches to dry for one month or so, he sets fire to the whole. When the ground is fully cooled the surface is slightly raked to work in the ashes, and afterwards sown with rági, hill paddy, or maize; a rough fence is made of the unburnt logs, and the cheena is left till the grain begins to ripen. After the first crop is reaped, gingelly, maniok, amu, or hén-kek (*Cucumus utilissima*) are usually taken off the land as a second crop, and then twelve months after the first clearing the soil is finally abandoned.

"Cheena cultivation has always in Ceylon enjoyed special advantages, as regards taxation, over paddy, the only permanent food grain cultivation, and this, combined with the enormous returns—reaching to 500-fold—which are obtained for the minimun expenditure of labour, has caused it to be a favourite method of cultivation with a thriftless indolent people. Paddy cultivation is most laborious, and requires unremitting attention and watching. The return is uncertain, especially since in late years the seasons have become so irregular. In cheenas, two slight showers are sufficient to ripen the crop. This, with light taxation, unlimited extent of land, and the possibility of securing by one month's labour, of which the wife and children can do a large share, sufficient grain for twelve months' consumption has, assisted by many other circumstances, caused this destructive form of cultivation in some parts of the country gradually to absorb all the forests. In the Blue Books between 1870 to 1881, it will be seen that the area of dry grain cultivation has doubled. The area of paddy cultivation in the same period shows no material

increase, notwithstanding the construction of irrigation works, whilst in some districts the revenue officers record a marked decrease, accompanied by an increase in dry grain cultivation. In whatever way we look at it, paddy cultivation has been at a disadvantage, especially when a native knows that, if he grows paddy, he must be subject to great extortion by the 'renters,' whereas to his solitary forest cheena the renter will not pay many visits, and then, although he has to give up one-fourth of the crop, it is better to do that, when the area can be easily extended, than risk the loss of the crop by having to wait until the renter choses to come and allow the paddy to be threshed.

"The effect of cheena cultivation is not only that an enormous amount of good material is wasted and burnt—the larger trees left standing being all killed by the fire—but the character of the vegetation is completely changed, and the more frequently the same area is cleared, the less the growth resembles the original forest.

"Cheena ruins a poor soil like that we have in Ceylon, and a thorny-stunted scrub growth comes up which only grows to a height of 20 to 30 feet. Only after seeds of the better kinds of trees are blown in from the neighbouring forest do timber trees once more grow up. Thus 40 to 50 years may elapse, and it is evident that as more forest is destroyed the less chance there will be of seeds finding their way to the cheena, whilst the more frequent the clearing the more the soil deteriorates. In this way, with nothing but cheenas for miles, it might take hundreds of years before the ground once more became clothed with forest, even if it were left undisturbed.

"The above are the results when the soil is only cultivated for twelve months, the reproductive power of the tree-stumps not being entirely destroyed; but in the Eastern Province cheenas are cultivated for three or four years. The Moormen of Batticaloa, now as in Sir H. Ward's time, supply the capital and the seed, whilst the poor Sinhalese or Veddahs get the cheena permit and cultivate, the Moors taking the greater part of the crop. Kurakkan is succeeded by maize, then come cucumbers, to be followed by maniok and, finally, plantains. The latter stand for eighteen months, and by the time the patch is abandoned the soil is so thoroughly exhausted that even the usual cheena scrub refuses to grow. Nothing comes up but Illuk grass (*Imperata arundincea*) and a few straggling stump shoots of *Pterospermum suberifolium*, which are gradually killed off by the annual fires, for in the Eastern Province every year during July and August the horizon is now darkened by the smoke of the burning grass on these old cheenas. The damage does not stop here, for each year a circle of trees round the burning patch is killed by the fire, and the area of grass extends itself, or the fire frequently rushes into the standing forest for some distance, damaging the trees and killing all the seedlings.

"The effect of this mode of cultivation in Ceylon has been less disastrous than in India and Burmah. There the population is large, the area of uplands suitable for growing dry grain crops is limited, and this, combined with certain restrictive regulations, has tended to confine the cultivation within narrow limits, forcing the people to return to the same land, and to clear it after only six to ten years'

rest. Both in India and Burmah there is also a long hot weather, drying up the soil and causing forest fires. The soil, exhausted with such frequent cropping, declines to grow anything but sparse jungle and grass, and the entire character of the country and climate is changed.

"In Ceylon the supply of land has always been large for so scanty a population; cheena crops can be grown anywhere, and fresh forest or 40 to 50 years' cheena growth has generally been available for clearing. Although the soil is so bad, the equable humid atmosphere and abundant rainfall cause a dense growth of thorny scrub to come up, which, though perfectly useless in other ways, serves at least to protect the soil.

"It is in the Sinhalese parts of the Island that the cheena cultivator has done most harm, and having had uncontrolled command over all the forest, has succeeded in clearing away most of it. The least observant traveller by rail to Kandy and Náwalapitiya cannot fail to notice the general absence of high forest, the enormous areas of scrub, whole hill sides—one unbroken sheet of dense bushy growth—the annual succession of clearings being marked by the different shades of green, from the grey of the recent clearing, to the bright green of the two or three-year old bushes, and the dark green of those ten years old. Or, ascending any of the peaks, he will see before him nothing but a vast sea of one uniform growth, consisting mainly of Lantana or *Beesha stridula** in the moist zone, with perhaps a wooded knoll here and there, which being too steep and rocky for cultivation, has been left; or, in the low dry country, he will be able to trace into the far distance the rivers and depressions, by lines of taller trees of darker hue, showing where the devastator has found Kumbuk trees, *Terminalia glabra* or Mi (*Illupi*, Tam.) *Bassia longifolia* too big for the axe, or where in the lower ground on the river banks, the scrub has grown up rather more rapidly. No more deplorable sight could be found, and the only reflection is, what might have followed similar ill-treament in a country less favoured in climate. The extent of cheena, in one unbroken stretch, is such as Burmah or India never saw.

"The Central Province has an area of uncultivated land of over three million acres. Allowing 100,000 acres for the reserved forests

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* *Beesha stridula.*—*Batali* covers thousands of acres in the Western and Southern Provinces. In the Southern Province, lantana has not spread so extensively as in the Western and Central, and this small bamboo, growing to a height on old cheenas of 6 to 10 feet, generally springs up within a year or so of the crops being reaped. It grows in dense thick masses, and like the Illuk grass in the Eastern Province, it gradually encroaches on the forest. After it has grown up to some height, the ground is covered with a dense mass of dry stems and leaves, which in dry weather take fire readily; each time the scrub is fired a fresh row of trees round the edge of the forest is killed, and the Batali replaces them. For the cheena cultivator nothing could be more convenient, as it saves him the trouble of clearing. In the Southern Province—the Hinidum Pattu especially—may be seen large areas of soil so exhausted that it will only grow ferns—*Gleichenia dichotoma.* Here, too, after two or three years' growth, sufficient dry material accumulates, to admit of the whole being fired. This the natives do as often as they can to induce tender shoots of grass to come up, and the forest is slowly but surely encroached on. The same process may be noticed in the Southern Province about Batapola, where the annual firing of the grass in the swampy low lands leaves its mark in the shape of dead trees on the edges of the surrounding forests.

at over 5,000 feet elevation, and 400,000 acres for patana land, roads, &c., the total area of good forest, out of 2½ million acres of waste land, is not more than 30,000 acres.

"In the large Kandy district with 316,000 acres of waste, there is, I am told, beyond a few rocky ridges at the lower end of Dumbara, one forest only (Tumpané). In the Badulla district, the largest in the Island, with 2,119,000 acres of uncultivated land, I was not able to hear of more than a few 100-acre patches on rocky knolls. There is an unbroken stretch of cheena from the Kumbukan-aar to the northern end of Bintenna, a distance of 60 miles. In breadth, this cheena scrub extends from the foot of the hills to the Eastern Province boundary, a distance of some 25 to 30 miles, the boundary line being distinctly marked—by cheena scrub on the Badulla side—by fine forest on the Eastern Province side. The only forests in the Central Province are in the Mátalé district, and here too the cheena cultivator is busy. Half of the district, at least, is said to be nothing but cheena and scrub, with patches of forest left on the very rocky slopes. Even when we come to examine the forests, they are found to be more or less cut up into small blocks by large intervening stretches of scrub.

"On the western side of the Island the state of things is very much the same. In the Western Province, with 1,400,000 acres of waste, we could probably not find more than 100,000 acres of good forest even including patches of 150 acres and under. In the Kégalla District, with 289,000 acres uncultivated, there are said to be no forests of over 500 acres. In the Kurunégala District, North-Western Province, with 600,000 acres uncultivated, we pass through nothing but cheena from Chilaw to Kurunégala, and thence to Diyatura, Nikaweratiya, and Polgahawela, a total distance of 90 miles, along which there is no large block of forest within 5 miles of the road on either side. It is the same in the Southern Province, or rather worse, if that were possible. Figures such as these, although they cannot pretend to great exactness, give a reliable idea of what destruction cheena cultivation has caused, and how intimately a solution of the question concerns the forests.

"In the drier parts of the Island immense damage has been done, but owing to the population being scanty, the areas cleared are on the whole much smaller. It is not, however, the difference in climate which has saved these forests, for the greater part of the Badulla District already alluded to is in the dry zone. It is in the latter, too, that the most marked increase of dry grain cultivation, accompanied by a decrease in the production of paddy, has of late years taken place. (See Annual Reports, 1880, Mullaittívu and Hambantota Districts).

"Without a record of the areas cleared for cheena, and until the vast areas of Crown land have been thoroughly explored, accuracy in estimating the area of the forests is impossible, especially when many of the so-called forests on the western side of the Island consist of small patches, generally under 100 acres, surrounded on all sides by cheena clearings. In the Western Province there are still some forests of workable size left on the Kélani-ganga, and on the Kalu-ganga, with larger ones in the inaccessible Kukulu Kóralé and Sinharája country. From some of the former revenue can always be made, but

many of the finest forests have, as is explained elsewhere, been sold along these rivers, and there is great uncertainty as to the actual extent still belonging to the Crown. In the southern parts of the Kurunégala District, and in the Galle and Mátara Districts of the Southern Province, the best forests have been sold or cleared, and the Crown is forced to get its timber from distant forests, difficult of access, or else to buy from the persons to whom it originally sold the forests.

"Any approximation as to the area, when so little is known, would therefore be valueless; and it can only be said of the moist zone generally, that the forests left are chiefly in small isolated blocks, and that their present area, if most carefully preserved from further diminution, will be barely sufficient for the ordinary requirements of the public.

"In the hill country the area of forest left is very small. There is a reserve of about 100,000 acres on the highest ranges at an elevation of over 5,000 feet. The only forests of any size at elevations under 5,000 feet are situated in the accessible country of Adam's Peak, on the south-west slopes, with an annual rainfall of 200 inches. These are to be retained as climatic reserves, and from their position would never be valuable for any but a small local supply of timber and firewood.

"In the dry zone the areas of forest are so large, whilst they are so mixed up with scrub, and such a large extent of country is still unexplored, that it would be useless to attempt any estimate of their extent. The uncultivated area is given at nine million acres, from which large deductions must be made for the coast belts, the Park Country, &c. The areas of cheena scrub too are so enormous, that without a detailed examination of the country block by block, with an accurate map, no approximation even can be made. With nothing but my own personal impressions to work on, and without official records to assist me, it would be misleading to give any figures. Probably one-third to one-half of the uncultivated area in the dry zone is covered with forest trees—not good forest, but valuable timber trees mixed with unsaleable or worthless woods in every proportion, often of course interrupted by considerable stretches of scrub.

The forest vegetation may be considered as littoral, and of the dry and moist zone. The littoral vegetation is much the same all round the islands, and consists of several species of mangroves. The cocoanut only flourishes in the moister portions of the coast, and towards the northern end of Ceylon is replaced by the palmyra palm with its 800 different uses.

The surya or tulip tree (*Thespesia populnea*) is a common avenue tree, but not indigenous, though its timber is much valued for coach building.

We give Mr. Vincent's description of the forest vegetation of the dry zone :—

General Characteristics of the Forest Vegetation in the Dry Zone.

"The forests are almost entirely evergreen, very few species being

ever leafless, whilst of those that do lose their leaves—satinwood, *Schleichera trijuga* (Kong), *Excœcaria* (Falconeria) *insignis* (Tilé)—only the last mentioned remains bare long. The distinguishing characters of the forests are great density and compactness of growth, general uniformity of size with inferiority of girth and height; a dense undergrowth of arboreous shrubs and sometimes nillu (*Stenosiphonium*), with a marked absence of herbaceous surface growth, such as grass, &c. In nearly all the forests we find the ground covered with a great variety of species crowded together, all struggling and hustling one another for light and air, without any being able to shoot up to a good height or to assume a dominant position. The average height of the trees is about 30 to 50 feet—rarely over 60 feet: all the species grow to the same height, three only—satinwood, palé and halmilla—making much show above the rest.

"When the trees have reached their maximum height they form very broad flat crowns, which interlace, and besides serving to throw an impenetrable shade on the soil, keep out the wind which blows so steadily for the greater part of the year. Above the flat umbrella-shaped tops of the other trees, satinwood and halmilla can be distinguished at a great distance by their isolated crowns. The girth of the trees is small, and after reaching a certain size never increases much. Except of satin and palé, trees of 6 feet girth are rare, and the majority of species forming the forests are never more than 3 feet in girth. Halmilla, one of the most valuable timbers, is rarely over 4 feet in girth. The absence of dominant trees is remarkable, as is also the want of predominance of one or more species in the forest, such as generally results from their superior vital power or from their longevity. Whether this and the small size of the trees are due to poverty and want of depth in the soil, is a matter for conjecture. The growth of all the species is very slow, with the exception of halmilla, which sometimes appears to be rapid.

"Instead of herbaceous undergrowth, (nillu being chiefly confined to inferior soil and open forests,) a dense undergrowth of arboreous shrubs or of seedlings of the larger trees springs up, forming a miniature forest 6 to 10 feet high, and rendering progress, except along a cleared path, almost impossible. There is a want of humus, the poor soil being covered only with a thin layer of leaves. Except during the north-east monsoon, the soil is generally dry, but at the same time well protected against the wind and the sun by the dense shade of the trees and the undergrowth. The south-west gales pass over the forest, unable to penetrate the dense growth, and the natural protecting barrier formed by the entwined crowns, and the air inside the forest is quite still.

"The most characteristic tree of these forests is *Hemicyclia sepiaria*—Véré (Wera-gaha, Sinhalese), with its curious fluted stem. It is the commonest in all forests of the dry zone, and in many there are more of this peculiar tree than of all the others put together. The stem assumes irregular shapes, rarely straight and round, with longitudinal flutings, which are often split off for axe handles; the girth seldom exceeds 2½ feet, with a low spreading crown. It appears to be often a sign of bad soil and of old cheenas, for some of the fine forests in the Eastern Province are almost free of it, whilst on ad-

joining patches, with many other unmistakeable signs of old cheena cultivation, it forms one of the principal trees.

"Another most characteristic tree, although not entirely confined to the dry zone, is *Terminalia glabra*, of little value as a timber tree, but forming a very graceful object round the numberless tanks, which are in themselves a remarkable feature in the scenery of this part of the Island. All the streams are bordered with it, and no other tree approaches it in size.

"The trees of the dry zone forests which yield the only timber saleable at present are:—

Ebony (Diospyros Ebenum).
Satinwood (Chloroxylon Swietenia).
Halmilla (Berrya Ammonilla).
Palé (Mimusops indica).
Milla (Vitex altissima).
Wavarani or Yavarani (Persea [Alseodaphne] semecarpifolia).

"The following are the commonest species mixed up with the saleable timbers :—

Venangu (Pterospermum suberifolium).
Murali or Mora (Nephelium Longana).
Moré (N. Gardneri).
Vedekanari (Diospyros ovalifolia).
Chemelpanichi (D. crumenata).
Panichi (D. Embryopteris).
Kulodi (Chickrassia tabularis).
Aili (Ulmus integrifolia).
Rukkatana (Alstonia scholaris).
Mi (Bassia longifolia).
Kaditeni (Sterculia fœtida).
Kanchura (Strychnos Nux-vomica).
Kuma (Glenieia zeylanica).
Punerai (Sapindus emarginatus).
Koketiya (Garcinia terpnophylla).
Tirkundel (Cassia Fistula).
Naval (Eugenia Jambolana).
Kolon (Adina cordifolia).
Helambé (Stephegyne parvifolia).
Kong (Schleichera trijuga).
Vela maram (Acacia leucophlæa).
Pieri (Elæodendron glaucum).
Tammana (Mischodon zeylanicus).
Kumbuk (Terminalia glabra).
Munamal (Mimusops Elengi).
Vammi (Sarcocephalus cordatus).
Lunimidella (Melia dubia).

"The following are the principal species comprising the undergrowth :—

Kaian (Memecylon edule).
Do. (M. grande).
Manchuvana (M. capitellatum).
Kannu (Austrutheria zeylanica).
Ulavinté (Polyalthia Korinti).
Karani (Webera corymbosa).
——— (Taxotrophis Roxburghii).
Klaka (Carissa diffusa).
Nelli (Phyllanthus Emblica).
Tuvere (Maba buxifolia).
Taintuki (Dimorphocalyx glabella).
Gulserú (Premna tomentosa).
Nillú (Stenosiphonium).

"Locally, as in the Eastern Province, the following become fine timber trees, and are common :—

Katupulian (Dialium ovoideum).
Mara Illipé (Polyalthia longifolia).
Nedunari (P. coffeoides).
Vella-karungali (Diospyros oocarpa).
Tumpalé (Vatica sp.) [*Beddome*].
Tombúkata (Calophyllum elatum).
Churapunné (C. Burmanni).
Do. (C. tomentosum).
Wild mango (Mangifera zeylanica).
Punné (Calophyllum Inophyllum).
Marungé (Eugenia zeylanica).

"For the majority of these woods there is not the least demand; occasionally in the Eastern Province a few wild mango, kumbuk or tombúkata are cut to make canoes, churapunné for the spars of *dhoneys*, or in the North-Western Province, tammana for building; but the small demand for all woods, other than those mentioned above, is best shown by the fact that for the last six years, the average annual number of trees cut on permit in the Batticaloa District has been only 65.

"The great variety of species has already been alluded to, but the small proportion of the valuable timber to the valueless is still more remarkable. The general condition of the forests is, that trees of one or more of the saleable kinds are mixed up with a very large variety of the valueless woods. The former never exist as a pure forest by themselves, and collectively, even in the most favorable situations, never form more than one-tenth of the whole. It is only in the fine forests of Bintenna, in the Eastern Province, and on some parts of the western coast, that satinwood, ebony and halmilla compose this share of the standing growth. In nine-tenths of the forests of the dry zone the saleable woods do not form more than 2 per cent. of the whole. Looked at from a professional stand point, the forests are most disappointing. They exhibit very poor growth, and the great mixture of species suggests at once great difficulties of management, and comparatively high working expenses. For our timber supply, the annual operations must cover a very large area, which will necessarily involve great cost in *road-making, &c., and in supervision.*

"Throughout the same great difficulty of treatment presents itself. The valuable trees are far apart and are much in the minority. They are slow growing, and especially in the case of one of the most important—satinwood—do not bear shade well. In cutting out an ebony or a satin tree we rarely find any young seedlings or saplings of the serviceable woods near. Forming a compact forest all round, are trees and saplings of all the unsaleable, valueless kinds, with a dense underwood of the same or allied species, ready to fill up the gap, and to choke any seedlings of the better kinds which may spring up.

"Before the felling, the seedlings of the better kinds of trees rarely take root in the dense shade, where they stand a poor chance in the struggle with the dense arboreous underwood. The latter, with its dark-green leathery leaves, scarcely suffers at all from the shade; it waits patiently for its opportunity, and immediately an opening is made, shoots upwards and soon outgrows the satin or the ebony seedlings.

"The bad reproduction of both ebony and satinwood, especially the latter, is very striking. In none of the forests, where fellings have lately been carried out, is a fair proportion of young trees to be seen, and I can only remember one forest in the North-Central and North-Western Provinces with any number of young satinwood trees.

"Of halmilla the reproduction is far better, but still it suffers considerably from the shade of the worthless trees, and has failed to reproduce itself completely over most of the large areas, which it formerly covered in the Eastern Province.

"With paló, reproduction is as unsatisfactory, and in the Northern Province, where this tree is quite at home, we notice everywhere the absence of young trees and of seedlings, other faster-growing ones having got the upper hand."

In the arid zone we read that palé is the principal tree, forming about $\frac{1}{15}$th of the standing crop, satinwood and halmilla are rare, and of ebony, owing to the destruction of the traders, comparatively little is left.

Mr. Vincent divides the moist zone into three sub-zones as follows :—

"The following are the divisions :—

ZONE 1.—*The Low Country*,...	Elevation, from sea level up to 2,500 feet. Rainfall, 60 to 100 inches.
ZONE 2.—*The Lower Hills*, ...	Elevation, 2,500 to 5,000 feet. Rainfall, over 100 inches.
ZONE 3.—*The Upper Hills*, ...	Elevation, over 5,000 feet. Rainfall, 80 to 100 inches.

"In addition to these may be added a zone, including the regions of the heaviest rainfall—100 to 200 inches—with a special endemic flora ;—elevation up to 7,000 feet.

ZONE 1.—*The Low Country*.

"This possesses a very rich vegetation of a purely equatorial character. Of trees, the following selection is fairly characteristic :—

Dillenia indica (Hondapara).
*——— retusa (Godapara).
Garcinia *spicata* (Kokati).
——— echinocarpa (Madol).
* Calophyllum Inophyllum (Teldomba).
* Mesua ferrea (Ná).
* Doona zeylanica (Doon).
* Vateria *acuminata* (Hal).
* Vatica Roxburghiana (Mendora).
* Dipterocarpus zeylanicus (Hora).
Bombax malabaricum (Imbul).
Eriodendron anfractuosum (Pulunimbul).
Canarium zeylanicum (Kekuna).
——— brunneum (Mahabullúmoragaha).
* Filicium decipiens (Pehimbia).
* Melia dubia (Lunimidella).
Walsura Piscidia (Kirikong).
* Schleichera trijuga (Kong).
* *Mangifera* zeylanica (Etamba).
Dalbergia frondosa.
Pterocarpus Marsupium (Malugaha).
* Pericopsis Mooniana (Nedun).
* Cassia siamea (Aramana or Wá).
Adenanthera bicolor (Masmorú).
Pygeum *zeylanicum*.
* Carallia integerrima (Dawata).
Terminalia glabra (Arjuna), (Kumbuk).
——— belerica (Bulú).
——— chebula (Aralú).
Eugenia Gardneri.
Eugenia aquea (Waljambú).
——— *micrantha*, &c.
Barringtonia racemosa (Mudilla).
Lagerstrœmia Flos-Reginæ (Murutu).
* *Homalium* zeylanicum (Liang).
Canthium didymum (*Porua-mara*).
Morinda bracteata (Ahú).
Chrysophyllum Roxburghii (Lawalu).
Bassia neriifolia (*Gan-mi*).
* Alstonia scholaris (Rukuttana).
Holarrhena mitis (Kiriwalla).
Oroxylon indica (Totilla).
Vitex Negundo (Notchi).
* ——— *altissima* (Milla).
Cinnamomum zeylanicum (Kurundu).
Myristica Iria (Iria).
——— *laurifolia* (Malaboddu).
Litsæa *tomentosa*, &c., &c., (Dawalkurundu).
Gyrinops Walla (Walla).
* Artocarpus nobilis (Del).
* ——— integrifolia (Kos) Jak [not native].
——— Lakoocha (Ebaheraliya).
Ficus laccifera (Nuga).
——— infectoria (Kiripella).
——— indica (Tjiela, Miq), &c., (Ella Nuga).
Mallotus (several).
Macaranga tomentosa (Bukenda).
Croton lacciferum &c., (Keppitia).
Briedelia retusa (Ketakela).
Cycas circinalis (Madu).

"There are in the undergrowth several species of Calamus and two species of Bambusa (*B. vulgaris* and *B. spinosa*). The Kittul (*Caryota urens*) is common in most forests of the low hilly country.

* These are the principal timber trees. The native names given are Sinhalese.

The talipot palm (*Corypha umbraculifera*) is characteristic of the western slopes of the hills at 1,000 to 2,500 feet altitude, and is specially noticeable on the Kandy railway incline.

The smaller shrubs and undergrowth comprise such species as numerous Anonaceæ, Allophylus Cobbe, Erythrospermum phytolaccoides, Hydnocarpus venenata (Makulú), Osbeckia aspera, Memecylon (several), Ixora coccinea (Ratmal), Wrightia zeylanica (Walidda), Premna tomentosa (Buseru), Blachia umbellata, Phyllanthus (several), and an abundant bamboo, Ochlandra (Beesha) stridula (Batali). Other interesting species are—Nepenthes distillatoria (Bandarawel), Exacum zeylanicum (Kinihiriya), Knoxia zeylanica, Elettaria Cardamomum (Ensal), Sanseviera zeylanica (Niyada), Gloriosa superba (Niyagala), Flagellaria Susum, Raphidophora (two species), Pothos scandens (Potha), &c. Many plants in these lists are peculiar to Ceylon, or at least do not occur in the Indian Peninsula.

ZONE 2.—*The Lower Hills.*

"In this zone, which may be reckoned to extend roughly from 2,500 to 5,000 feet, the great clearings for coffee estates have mainly been made, and the native vegetation has proportionately suffered. It was formerly the orchid district of Ceylon, but several species once found are now probably lost, whilst many others have become very scarce.

"The following trees may be given as characterizing the lower hills, though many are by no means confined to them:—

* Calophyllum tomentosum (Kina).
* Doona Gardneri (Doon).
* Vateria Gardneri.
Cullenia excelsa (Katuboda).
Aglaia apiocarpa.
Mastixia arborea (Diatalia).
Pithecolobium subcoriaceum.
* Carallia calycina (Ubberia).
Terminalia parviflora (Hampalanda).
Eugenia Jambolana (Mádan).
*——— operculata (Batadomba).
——— Neesiana, &c.
Careya arborea (Kahata).
Isonandra Wightiana.
* Mimusops Elengi (Munamal).
Diospyros sylvatica.
——— Toposia.
Olea glandulifera.
Fagræa obovata.
——— Gardneri.
Chloranthus brachystachys.
Machilus macrantha.
Helicia zeylanica.
Ficus Wightiana (Kalaha).
—— dasyphylla, &c. (Kirinuga).
Celtis cinnamomea.
Scleropyron Wallichiana.
Ostodes zeylanicus (Wal Kekuna).

"*The undergrowth is largely composed of nillu (Strobilanthes, of* which some seven or eight species are found at these elevations) and species of Amomum and Zinziber; there are also many Balsams (Impatiens), Gesneraceæ, parasitic Christisonias, &c. The magnificent climbing epiphyte, Kendrickia Walkeri, formerly common, is also an ornament of the few remaining patches of forest in this region.

ZONE 3.—*The Upper Hills.*

At about 5,000 feet the mountain flora proper begins; our altitudes, however, are nowhere sufficient for the growth of anything like an Alpine vegetation. The trees are, with few exceptions, low, and are often marked by their small thick coriaceous evergreen leaves. The following may be mentioned as characteristic species:—

Michelia nilagirica (Sapu).	Eugenia rotundifolia.
Calophyllum Walkeri.	—— sclerophylla.
Gordonia (3 species).	—— mabæoides, &c.
Elæocarpus obovatus, &c. (Galwe-ralu).	Rhododendrom arboreum (Mabarat-mal).
Ilex (2 species).	Symplocos obtusa.
Meliosma pungens.	—— læta, &c.
Semecarpus coriacea.	Olea Gardneri.
Pygeum Wightianum.	Cinnamomum ovalifolium.
Photinia Notoniana.	Actinodaphne (4 species).
Sarcococca pruniformis.	Litsæa (5 species).
Eugenia calophylla.	

"A very handsome tree-fern, Alsophila crinita, and six species of small bamboos are also noticeable.

"In these mountains, however, it is rather the herbaceous and shrubby plants that attract attention, many being members of European genera. The others are generally members of genera found in the mountains of Southern India. In most cases the species are *distinct and usually endemic. As examples may be noted—of the* first-class, Ranunculus (2), Viola (2), Berberis, Geranium, Rubus (2 or 3), Alchemilla, Agrimonia, Heracleum, Galium, Dipsacus, Campanula (2), Gentiana, Calamintha, Plantago, Juncus (2), &c.; and of the second, Impatiens (about 12), Osbeckia (3 or 4), Sonerila (6), Hedyotis (12), Anaphalis (7), Lobelia, Exacum (2), Strobilanthes (9 or 10), &c.

"Grasses and sedges are numerous, as well as orchids, both terrestrial and epiphytic, and ferns.

"There are no native species of Cupuliferæ or Coniferæ in Ceylon.

"The present state of the greater part of the hill country, as modified by coffee planting and cheena clearing, does not afford many opportunities of examining the forest vegetation. Up to 5,000 feet, nearly all the forests have been cleared for coffee estates, and owing to this and the destruction caused by cheenas, there are probably not 5,000 acres of original forest left between 2,000 feet and 5,000 feet. The indigenous species have been supplanted to a great extent by foreign secondary growths, the principal being the lantana; said to have been originally introduced by General Lowe in 1833 from the West Indies, this plant has spread over the whole of the moist zone, including the hill country up to 3,500 feet.* From sea level upwards, all the abandoned coffee estates and cheenas are covered with a dense tangled growth of lantana, never over 6 to 8 feet high, to the entire exclusion generally of other species. In the drier parts of the Island the spread of this pest has been less rapid, but one can watch its annual progress along the roads leading towards the eastern and northern coasts. After seeing the enormous lantana-covered areas and the dense matted growth covering the soil, it looks almost hopeless to think of tree-forest once more covering the land without artificial aid. Of other introduced species, the commonest are *Mimosa pudica, Mirabilis jalapa, Passiflora fœtida, Ageratum conyzoides*, the latter being the worst weed on coffee estates. Most of these and the

* Lantana has also overspread Australia and Tasmania. In the Nilgiris it goes up to an elevation of 5,000 to 6,000 feet, but in Ceylon 3,500 feet is the extreme limit.

many other introduced species, which have now spread so extensively, originally escaped from the Royal Botanical Gardens at Péràdeniya and Hakgala.

"The principal timber trees are included in the above lists. Of these, calamander* and nedun are the only cabinet woods; jak and milla are durable for building—the former being the principal furniture wood of the Island; of both the supply is limited, and the prices asked in Colombo are very high—such as Rs. 2 per cubic foot for jak† scantlings—owing to the only other good building woods—such as satin, palé, &c.,—having to be brought from the distant dry zone forests. The other woods, hora especially, are used for indoor work, for native houses, for coffee and plumbago casks. In the hill country the only woods used are doon for shingles and rafters, liangu, sapu, keena, domba.

"The forests here have been little affected, except in the case of cabinet woods, by the depredations of the traders. In the forests of the dry zone the valuable trees are scattered, and a man to make money has to spread his operations over a large area. Here, the timber dealer preferred buying the best of forest land, with standing timber worth Rs. 300 to Rs. 400, at an upset price of Rs. 10 an acre, with Rs. 2½ survey fees, to taking out a permit for a certain number of trees and paying a royalty on each stem. The disastrous effect of this policy not only in actual monetary loss, or in the neglect of this valuable and permanent source of revenue by Government, but in its depreciatory effect on the rest of the forest lands, and in the openings given for theft when protection was entrusted to local headmen, and when the law afforded assistance neither in checking forest destruction nor in controlling the transit of timber, may be better imagined than described.

"The cabinet woods, such as calamander and nedun—the former especially—have been almost exterminated from these forests by permit holders, and in a great measure by theft. At one time both were comparatively common, yet now in the restricted area in which calamander grows well—the Ratnapura District, the Pasdun Kórale and the Hinidum Pattu—so few trees are left, that the position of each can be given by the older local inhabitants.

"Little durability though the softer wood possess, there is considerable demand for them in Colombo, and along the coast between Negombo and Mátara, and large fortunes have been made by purchasing blocks of forest land, and utilising the timber for cask-making and other purposes, for which the hard woods are too expensive or too hard to work. There is an entire absence in Ceylon of light durable timbers, such as teak, and consequently, hora, mango, and other inferior woods find more favour than they merit.

"The teak tree may now be considered naturalized in this part of the Island. Originally introduced by Van Rhede, towards the end of the seventeenth century, numerous plantations were made under the Dutch Government, and being specially protected by most wise provisions, it spread over the greater part of the coast districts.

* Known in the timber trade as Coromandel wood.

† Jak timber comes now almost entirely from private land.

Under British rule the tree no longer enjoys special protection; most of the original plantations have been sold or the timber cut, yet it still continues to spread, notwithstanding its numerous enemies. Of teak timber there can be no talk, when even in Government plantations the trees are lopped, and on private land the smallest poles are cut. But the growth is good even on the poorest soils, in situations not too much exposed to the wind, and the further cultivation of the tree merits early attention. The imports of teak into the Colony are considerable; it is employed for the flooring and beams of all larger buildings, for which there is no suitable Ceylon timber."

In his chapter on the sale and export of forest produce, Mr. Vincent states that the local consumption of timber is very small, and that that from Government forests has to compete with wood from private lands and with Burmah teak; for inferior timber and firewood every one helps himself from the cheenas, and that the collection of minor produce, such as orchilla weed, the bark of *Acacia leucophlæa*, tan stuffs, palé fruit, gum, &c., has hitherto been either free, or the royalty realized has been unimportant. Under these circumstances Ceylon forest management must look to foreign export and endeavour to meet the demands of the timber trade.

Regarding the markets we quote as follows :—

"The following are the principal timbers exported from Crown lands :—

"*Ebony.—China Market.*—This wood is exported to China principally. In China, ebony is used for making chop-sticks and small pipes, the latter being the most important. The wood is shipped from Ceylon to Shanghai, and thence most is taken to Ningpo, where the chop-sticks, &c., are manufactured. For this market logs of about 5 cwts. are preferred, but a deep jet-black colour is the great object. For pipes only the best black wood is taken, fair-sized straight logs being preferred, but for chop-sticks inferior wood is generally used. For the best black wood any price will be paid, and Ceylon has the monopoly of the market. The following estimate of the shipping and other charges on ebony sent to China has been kindly given me by Messrs. Whittall & Co. :—

	Rs.	cts.
Receiving, weighing, marking, and shipping, per ton,	5	0
Freight to Shanghai (say) per ton, ...	30	0
Marine Insurance, &c., on (say) Rs. 130, ...	1	30
Import duty, landing charges, &c., in China, ...	12	50
Seller's commission, 5 per cent. (say), ...	7	0
Total, ...	Rs. 55	80

"To estimate the capacity of the China market, the average annual export for the five years, 1872-76, may be taken. This was about 300 tons, and as during that period prices were high, 400 to 500 tons can probably be yearly absorbed.

"*Europe Market.*—In Europe, ebony has of late years been largely replaced by ebonised wood—American birch being chiefly used—and

there is now comparatively little demand. It would appear, however, that there are still considerable dealings when the market is not glutted, and a good quality of wood is brought forward. The European market, including the United States, although not so steady as the China one, is still considered able to absorb about 250 tons a year. Ceylon wood continues to fetch higher prices than that from Bombay or Mauritius. At the present moment the price may be taken at £9 to £10 a ton, whilst for Bombay and Mauritius wood the prices are £8 to £10* and £6 to £8 respectively. In the London market only logs of 8 to 10 cwts., straight grained and free from knots, fetch the highest prices.

"*Bombay Market.*—In Bombay, the only Indian port to which I have been able to trace ebony exports, the prices are quoted at—

Logs from 5 in. to 10 in. diameter, 4 ft. to 9 ft. length	1 rupee per maund of 28 lbs.
Logs over 10 in. diameter, 1 rupee 4 annas	do.

"These prices are equivalent to Rs. 80 and Rs. 100 per ton, and Bombay might be tried for disposing of limited quantities of the small timber, which spoils the China and London markets.

"*Kalamander or Coromandel wood* is scarcely worth noticing, as none has reached the London market for years, and there is no prospect of future exports.

"*Satinwood.*—Small quantities are taken to Europe, but the consumption there is very small, and the value of the wood for furniture is not known as much as it merits. The market is at present glutted with an over supply, and the brokers, who were selling wood twelve to fifteen months ago at £20 a ton, cannot now get £6.† In Ceylon, satinwood is used for building, furniture, &c. Old satin trees are frequently hollow-hearted to a height of 8 to 10 feet from the ground, and these hollow logs fetch high prices as kottús or well-pipes—*i.e.*, as a casing for surface wells. In the Batticaloa District and in other parts of the Island no other wells are used. The greater part of the satinwood cut is exported to Madras, where it is used for furniture and general building purposes.

"*Halmilla or Trincomalee wood.*—This wood is exported to Madras in log. It is used for boat-building—the Masula boats being built of it, and by the Madras coach-builders; some goes to the Trincomalee and Bombay Dockyards and to the Madras Gun Carriage Factory.

"*Palé or Ironwood.*‡—Nearly all the timber cut is taken to the Indian ports, whence it is carried for some distance inland. It is used for door posts, window frames, roofing, &c.

"*Yavarani or Rana* is used in India for ordinary building work, and also for boat-building, as it resists the attacks of the teredo.

"*Milla—Lunumidella—Poon-wood.*—Small quantities of milla are taken to India, and a good deal of lunumidella (*Melia dubia*). The

* Bombay ebony comes from *Diospyros Melanoxylon;* Mauritius ebony from *Diospyros tessellaria.*

† It is difficult to reconcile the Customs figures with this statement when they show that only 270 logs have been sent to Europe in the last three years.

‡ *Mimusops indica.* There are no exports of *Mesua ferrea,* the ironwood of the moist zone.

latter is used for the out-rigger floats of Ceylon canoes, and for catamarams in Madras. The wood is very light and fairly durable.

"From the eastern coast where land has been sold for cultivation, a good deal of wood is shipped to India; it consists chiefly of small churapunné posts (*Calophyllum Burmanni*). Of *Calophyllum tomentosum* and *C. elatum* (Poon wood) there are said to have been exports not long ago, spars being taken as far as Calcutta and Bombay, but since the number of sailing vessels has diminished, there has been no demand. When spars are now required by ships at Colomba or Galle, liangu or doon is supplied, or Norway pine.

Forest Produce other than Timber.

"The exports of other forest produce are unimportant. That of firewood from Crown land was stopped in 1864. Small quantities of tanning bark (entirely mangrove, I believe, coming from different parts of the coast) are exported to India, but the only other exports of importance are orchilla weed and punai nuts. The latter are the fruit of *Calophyllum Inophyllum*, or of others of the same genus, shipped to India for the sake of their oil, which is said to form 80 per cent. of their weight. Orchilla weed is a lichen (*Roccella Montagnei*), common on the trees in the stunted coast forests of the dry zone, and is used for making litmus paper, and for dyeing.

"The dried fruit of the palé (*Mimusops indica*) is exported to India from the Northern Province. When the fruit ripens in the summer, almost the entire population (men, women, and children) of the islands in Palk's Straits (Delft, The Two Brothers, &c.) migrate to the palé forests of the Northern Province. Here they live for a couple of months on the small sweet yellow fruit, and also dry large quantities for sale in Jaffna and the Indian ports. To collect the fruit the branches are lopped off, immense harm being done to the trees. The forests that suffer most are those within five miles of Palavarayankádu, where every tree is more or less rotten from the continuous lopping it undergoes. Wherever the palé grows it is lopped for the fruit, and although this wasteful means of collecting may be difficult to stop entirely, it should certainly be regulated in the more valuable coast forests. Small quantities of velam bark—the bark of velamaram (*Acacia leucophlœa*)—are also exported from the Northern Province to the Indian arrack distilleries.

"*An increased outturn only benefits the dealers.*—If all but the cabinet woods were consumed in the country, and if by putting more wood on the market or by reducing prices, consumption would be stimulated, one great difficulty of forest management in Ceylon would be removed. It will be seen in the next chapter, that the outturn of the forests has only been increased to benefit a limited number of dealers.

"*Effect of over-production—Ebony.*—Taking the case of ebony, in the returns it will be seen that the average annual exports of the triennial period—1876-78—were 15,000 cwts.; in the next period—1879-81—they rose to 35,000 cwts., the exports of one year (1881) being 52,000 cwts. The result of this was not to bring more revenue to the Colony, or to stimulate consumption by lowering the price of the manufactured article. The following extract from a letter of

Messrs. Jardine, Matheson & Co. will show the effect it has had on the ebony trade in China :—

"'While the imports of ebony were limited, a regular and satisfactory business was practicable, but during recent years imports have exceeded the consumption, and we have in consequence seen dull and depressed markets, accompanied by unremunerative rates. Imports during the past five years to this port are :—

	1877.	1878.	1879.	1880.	1881.
Piculs, ...	10,300 ...	16,900 ...	17,684 ...	18,450 ...	—
Value of best black-wood—Taels,...	4·00 ...	3·75 ...	3·40 ...	3·00 ...	2·80 (per picul of 133⅓ lbs.)
	(Rs. 12·00)...	(Rs. 11·25)...	(Rs. 10·20)...	(Rs. 9·00)...	(Rs. 8·40)

To-day's (September 15) quotation is taels 2·60 (Rs. 7·80).'

"The effect of this policy in Ceylon is alluded to elsewhere, and although few sales have taken place in the last twelve months, ebony is still unsaleable, except to middlemen willing to buy at about the same price as satinwood, on the chance of a re-sale to shippers.

"*Excessive supplies of Satinwood and other timbers.*—Over-supplies of other export woods have had the same effect on the Indian trade. In the Madras Presidency, where there is in many parts great scarcity of timber, the demand for timber is no doubt very large, but here, as in Colombo, the dealers stand between the producer and the consumer. A reduction in price only means larger profits to the dealer, for the latter, when he buys cheaply, is able to hold out for even higher prices than if he had, with borrowed capital, to realize quickly. Unless, therefore, by some means we can stimulate the demand, by giving the consumer the benefit of a reduction in prime cost, it is useless increasing the production.

"*The foreign markets to be carefully watched.*—The markets abroad require to be very carefully watched, and the supplies regulated entirely in accordance with the demand. The men who ship timber to India are all more or less connected by caste and by business relations, and to resist their combinations the only way is to find out from India what demand exists. If they are not satisfied with a fair trade profit on the price paid here, means must be taken to secure a larger circle of buyers by shipments to the Indian ports.

"*Cost of timber in Madras out of proportion to the price paid in Ceylon.*—No steps have as yet been taken to regulate prices in Ceylon by those current in Madras; consequently, I find that halmilla is being sold to the Madras Railway Company at Rs. 3-8 per cubic foot, and satinwood at Rs. 2-8, which must have cost landed in Madras about Re. 1-4. This is but one solitary instance, but there is every reason for supposing that prices, out of all proportion to those we receive, are charged all along the coast.

"*Correspondence with foreign Markets.—Supplies to be limited.*—In the ebony trade a combination of this sort is not likely to re-occur, if the policy of selling to native middlemen is finally abandoned. But here, too, the Forest officer must adopt precisely the same means for securing reliable intelligence from foreign markets as the people with whom he is dealing, and no longer work blindfold with sharp men of business. There is no reason why we should try and part with all our timber as rapidly as possible; and unless fair prices are paid, it is

better to hold back supplies. With ebony, of which the supply is so short, this should certainly be our policy. It is far better to sell 1,000 tons at Rs. 100 a ton than 2,000 tons at Rs. 50, if the difference in price is only pocketed by the dealer.

"*Palmyra Rafters and Reepers.*—It is to the large trade in palmyra timber grown on private land to which I would chiefly direct attention. The palmyra palm (*Borassus flabelliformis*) grows only in the dry zone—the island of Mannár and the Jaffna peninsula being its principal home. It here attains a height of 60 feet, with a girth of 2½ to 3 feet in the female, and 2¼ feet in the male trees. It attains its full size at 70 or 80 years according to soil and climate. The trees are grown 6 to 10 feet apart, the latter distance being considered best for rapid growth. Where the palmyra grows the Tamil is said to come, and the numberless uses for each part of the tree explain why he sows it. There are said to be 801 uses for the tree, its leaves, sap, &c. Every part is fully utilized, and in the Jaffna peninsula it furnishes employment to a large number of people who draw the sap for toddy or for jaggery, and live for several months in the year on punatto and on kelingoes. Punatto is the dried pulp surrounding the ripe palmyra nut; kelingoes are the freshly germinated palmyra seedlings, which are boiled and ground into flour; the latter is mixed with jaggery and made into cakes.

"*The Timber.*—The most valuable product of the tree is its timber, for which there is an unlimited demand in India. The heart of the tree is soft, but there is a broad shell of outside wood, consisting in the female tree of an almost solid mass of thick vascular bundles: in the male tree the vascular bundles are separated by more or less cellular tissue, and the wood is lighter and less valuable, whilst the outturn is less. The female trees are taller, straighter, of greater and more equal girth throughout. About 16 male trees are said to be equal to 13 female, the value of a female tree being Rs. 2½ against Re. 1 for a male."

In the 21 years 1859-1880 an average of over 27,000 palmyra trees have been annually felled, the export of palmyra rafters in 1881 being valued at Rs. 65,000. Mr. Vincent remarks—

"To determine whether the supply of palmyra timber is falling off is a matter of considerable importance. The palmyra at present only grows in any quantity in Jaffna and Mannár; in the former the population is rapidly increasing, and cultivation is spreading over a very limited area. Under these circumstances, when a good price is offered for palmyra timber, it is to be feared that fresh sowings do not keep pace with the fellings. Certain small areas are planted every year with palmyras near Jaffna and the larger villages where the toddy rents make the trees valuable, but no systematic attempts are made to keep up the supply of timber. No rule exists, as in Tinnevelly, that for every tree felled another must be planted, and there is too much reason to fear that the large decrease in the exports is due partly to a failure in the supply. The Tamils throughout the Jaffna peninsula derive no small portion of their food from the palmyra products, whilst a large number may be said to live on the

tree entirely. In the spring they make jaggery; during the rest of the year they live on the money so earned, and on punatto and kelingoes. Apart from the timber supply, the maintenance of palmyra groves is, therefore, of considerable importance."

We will not follow the report through the lengthy account of the Ceylon timber trade, it is sufficient to say that the permit holders were practically without any efficient supervision, and helped themselves to enormous quantities of timber in excess of the amount paid for to Government. Mr. Vincent summarizes as follows :—

"In every way the old license system was bad and ruinous. There were no means of preventing illicit felling, or of protecting the standing timber from injury and damage; no thought of replanting or of assisting the natural process of reproduction, whilst, in the simple matter of revenue, Government did not receive its proper share of royalty. The latter was rated first at 10 per cent., afterwards at 25 per cent.; yet when ebony was selling at £8 to £12 a ton, trees averaging 5 cwts. at least were sold at 96 cts. to Rs. 2 a tree.

"The evils of this system attracted the attention of the Hon. John Douglas, the present Colonial Secretary, then Auditor-General, soon after his arrival in the Island, and he issued a circular calling for reports as to the levying and collection of timber revenue, and the general management of the forests. The replies, unanimous in a condemnation of the existing arrangements, were reviewed by Mr. Douglas in a letter addressed to the Colonial Secretary in June 1871, and it is from this letter that we may date all the recent improvements in forest administration.

"Mr. Douglas's principal suggestions were that Foresters should be appointed to the Eastern and Northern Provinces (those being, as we have seen, the principal timber-producing districts), and that their duties should consist in the selection of trees for felling, the right to cut and utilize the timber marked in a certain area being sold by auction to the highest bidder. The proposals also comprised details of what the Foresters' work would be, and other matters which have not as yet received the attention they fully merit. The establishment of nurseries to be kept up by guardians in charge of irrigation tanks, and the replanting of cheenas with teak, jak and other trees on planting leases were mentioned.

"The result of these suggestions was that Foresters were appointed by Sir W. Gregory in 1873 and 1874 for the Eastern, Northern, and Southern Provinces. The Forester's post in the Southern Province was abolished in 1874, owing, I believe, to the timber trade being almost entirely in the hands of private persons, who bought large areas of forest at nominal cost in 1830–40. Similar appointments were made in the North-Central and North-Western Provinces in 1877. In the Central Province, the Superintendents of minor roads were from 1875 appointed supervisors of forests in addition to their usual duties, on salaries of about Rs. 500 a year. A Forester has lately been employed to check cheena cultivation in the Kandy and Mátalé Districts. The persons selected for appointment as Foresters were, in the case of the Eastern and North-Central Provinces,

officers of the Public Works Department; in the other Provinces they had not previously served under Government.

"The rules for Foresters, given in Appendix B., were issued in October, 1874, in substitution of those first issued in 1873. They still remain in force. In addition to these rules the Foresters had for their guidance certain suggestions drawn up by the late Dr. Thwaites, Director of the Botanical Gardens, Péradeniya, which related chiefly to measures for replanting, for assisting the national reproduction by clearing away scrub and creepers, and for the introduction of more valuable kinds of timber.

"The Foresters were placed in subordination to the Government Agents in all their work, maintaining, however, a somewhat distinct organization in office work and in matters of general routine, instead of forming part of the provincial revenue administration. In 1873 it was not considered advisable for Government to take the responsibility of working out timber from the forests, owing to the unfavourable results of a so-called experiment made in the Badulla District, of entrusting a Public Works Officer with the felling of timber. It is as well, though, here to notice, that the felling and conversion of the Monaragalla timber failed from defective superintendence, and owing to the position of the forests—14 miles from a cart track across hilly country. It was quite a misnomer calling it an experiment, when no one would care to buy timber without some means of carrying it away being provided. The timber consequently remained to rot in Mupané, where I saw it in July last. In the Western Province a small quantity of timber was also cut by Mr. Elliott for the Kalutara bridge from the Pasdun Kóralé, which did not prove a financial success. Small experiments of this sort are worse than useless, and it should be remembered that timber operations require, if they are to be brought to a profitable conclusion, most careful organization and more of personal superintendence and individual exertion than perhaps any work ever attempted by Government.

"Under the revised rules of 1874 the Forester's were to undertake timber works themselves on what is known as the *direct system of working*, the arrangement being that the contractors should fell and bring to depôt the trees selected by the Forester, the timber being afterwards sold by public auction, payment being made for felling and transport at a rate—per log or per cubic foot—previously agreed on. The second paragraph of the Forester's rules directs that the trees to be felled should be marked by the Forester. This I find has been neglected except in the Eastern province. Contractors have been allowed to select the trees for felling, to cut them very high above the ground, and to waste timber in cutting up and squaring. The Forester has not always visited, or ascertained the position within some miles of the place where felling was going on. I have reported separately on the subject, as it is one of the most important duties of the Forester to choose the trees for felling, and himself to see that the whole of the timber is utilized to the best advantage; not to trust to contractors and cartmen, who will always consult their own interests.

"All timber works appear to have been conducted on the direct system until 1879, when what are know as the '*share of timber*' and

the '*share of proceeds*' systems were invented. Of these, a short explanation will be necessary, nothing of the kind having, so far as I am aware, ever been attempted before.

"The *share of timber* working consists in the contractor bearing the cost of bringing a certain number of logs to depôt, receiving in payment a share—generally one-half, sometimes two-thirds—of the timber delivered. Under the *share of proceeds*, the contractor similarly bears all the expense of felling and carting in return for a share, previously agreed on, of the money received at the Forester's sales. The timber is delivered in depôt, and auction sales are held there.

"A desire that all revenue officers have of wishing to swell their receipts at all costs, to make the maximum of revenue with the minimum of expenditure, can have only originated the system, coupled as it was with a mad competition in forest revenue between the different Provinces, carried on without the least thought for the welfare of the forests, or of the real interests of Government. The budget allotments were unequally divided amongst the different Provinces, and in the absence of some control it was possibly natural for the Government Agent and the Forester to invent some system by which, say, the North-Western Province would appear in nett forest revenue not behind other Provinces which were more fortunate in securing large timber votes, and which were, therefore, able to bring out more timber by direct money payments. When the annual votes for timber works did not suffice to keep all applicants for contracts fully employed, these methods of making revenue without any expenditure were at once made use of. Contractors desirous of making large profits were only too willing to work on terms so unfair to Government, so remunerative to themselves, which, moreover, offered some of the many chances of sharp dealing so dear to natives.

"The many disadvantages inseparable from any such arrangement are self-evident, but the want of proper system and central control involved many others, work having been conducted in the following way—

"Having prospected with the help of veddahs or of village Sinhalese and found a forest conveniently situated, the contractor made his offer to work out a certain number of logs for a share of the timber or of the sale-proceeds. The contract being signed and the necessary permit issued, the timber cutters and cartmen were sent to the forest. The cutters were allowed to select the trees for felling, to cut as many as they liked, and to log and square them at discretion; the carters then removed the timber, little attempt being made to control the work from first to last.

"The contractor himself did not always visit the forest. Even when he provided the bullocks and carts, he sublet the felling and logging contract to timber cutters, who again employed the Sinhalese to find suitable trees at a fixed sum per tree, these people also agreeing to clear a cart track leading to each. Under this system every one consulted his own convenience. The cutter took such trees as were most convenient, the cartmen and cutters alike preferred short light logs to long ones, and generally one is inclined to question the advantages over the license system of work on these lines, when the openings for great waste and theft are so patent.

"After the contractor had carted all the timber to depôt and obtained his share, it competed in the market with the Government timber. Having borrowed his working capital he was obliged to sell soon. Large quantities thus thrown on the market only forced down prices, and the Government share sold usually at much lower rates than if the whole had been sold by Government.

"*No measures were taken to check the number of trees felled or* their outturn, to check the carts going along the roads, or to see if the arrivals in depôt corresponded with the fellings. Receiving a share of timber, the contractor had only to mix up this share with stolen timber to defy detection."

Regarding the disadvantages of the share system we read as follows:—

"The financial disadvantages practically amount to this: to bring one ton of ebony to market—work which we can get done for Rs. 15 in cash—one ton of ebony was given to the contractor having an intrinsic value of, *at forced sales, Rs. 52; at open market prices, Rs. 90* to Rs. 110. Surely Government credit is not so low that it cannot get sufficient money to work out a few tons of ebony at Rs. 15 a ton, instead of giving three to six times as much by paying in kind! The price of other timber might sink so low, that it would be to the disadvantage of Government making a cash payment for wood difficult of transport, of low value, and uncertain demand. But with ebony, having such a high intrinsic value, this could never be the case. The demand is steady, the supply is limited, and the Ceylon Government has the practical monopoly of the China market. Anything so entirely opposed to commercial principles can hardly be imagined, and the large actual loss shown by no means represent the losses which Government must suffer for some time from an overstocked market.

"The financial disadvantages, however great, do not by any means equal the administrative evils which I have already mentioned, nor do they represent the waste of timber which always took place. In Pallakelle forest, 25 miles north of Kurunégala, I found that a Tamil, dismissed from the Public Works Department, and working here on share contract, had felled and left many fine pieces of ebony, some of which had been cleaned by the fellers, others being untouched. This was seen in a short walk through the forest, not in making *a detailed inspection.* In the same forest there are some of the finest halmilla in the Island—trees 5 to 6 feet girth, running up 50 or 60 feet to the first branch. The contractor had been felling a large number, removing only the butt end logs and leaving more good timber than he removed, owing to a fall in the market price of timber causing the contract to be less profitable than when commenced.

"Experience in India has taught that auction sales of good timber rarely succeed, and Ceylon experience points in the same direction. The native purchasers always combine to keep down prices, and a reserve price is fixed which the buyers seldom bid up to. The time of the Forester is consequently wasted in going through the form of an auction, *in leaving proper forest work and going to and from* the sale depôt, when it is a foregone conclusion that none of the timber will be sold.

"The monthly sales at Trincomalee were held under the supposition that Colombo firms would send representatives to bid for ebony, &c.; this they failed to do owing to the great expense and difficulty of getting there, and partly owing to a reserve being fixed, often out of all keeping with the prices current in London and China. The trade was therefore left entirely in the hands of local chetties, who combined to keep down prices, knowing perfectly well that ultimately the price must be reduced. Combination gained the day, and finding that the local authorities were ignorant of the current prices in Colombo, &c., the finest timber was ultimately secured here and elsewhere at very low rates.

"Wood sold by auction is bought up by natives and re-sold at a heavy profit. The fall in price at the Government sales is not met by an equivalent in the Colombo market prices. Satinwood sells retail for the same price now as it did two years ago. With ebony, we find a difference of 100 to 200 per cent. in the price paid to Government and that which shippers in Colombo have to pay. The timber trade is at present in the hands of a few middlemen, who combine to keep down prices at Government auctions, and to keep them up in Colombo The finest ebony on the Mutwal beach was bought at a Government sale for Rs. 25 a ton; adding Rs. 15, the actual cost of carriage to Colombo, it was laid down for Rs. 40 a ton: the owner will not sell under Rs. 90. In the same way at Polgahawela, Rs. 30 only were bid for a class of wood selling for Rs. 70 to Rs. 90 in Colombo.

"The following extract from a letter received from Messrs. Churchill and Sim, the leading timber brokers in the London Market, will show how far the market has become overstocked:—'The market here for satinwood has been completely glutted with wood for the past six months, and we now hold a large stock for which we cannot obtain £6 per ton (of 50 cubic feet), whereas twelve to fifteen months ago we were selling at £20.' £6 a ton is equivalent to about Rs. 30 in Ceylon, or about 60 cents a cubic foot, freight and other charges *coming to £3 a ton or more. Satinwood is, therefore*, 25 per cent. cheaper in the London Docks than in the Ceylon Government sale depôts.

"Even in arranging the sale measurement of timber some supervision would have benefited Government interests. Ebony is always *sold by the ton weight, and in the trade is invariably weighed when* sold. At Trincomalee, the Forester of the North-Central Province told me he was allowing 40 cubic feet measurement to the ton. As Ceylon ebony weighs about 75 lbs. to the cubic foot, or 30 cubic feet to the ton, I recommended a reduction of the allowance by 25 per cent., and that the actual weight be always ascertained. In the Mátalé District, the ebony was neither measured nor weighed, but a 'liberal estimate' was made of the weight. Had there been any *control, or the least comparison* of results and working, this extreme liberality with Government property, presenting the purchasers with 20 to 25 per cent. more than they paid for, would have been obviated.

"Going through a forest worked by the traders, one is struck by the number of rotten ebony trees. Almost every stem over 4 feet in girth has a large gaping wound, where the feller 'tapped' for the

black heartwood. The quantities of heart and sapwood vary very much, so if after tapping he found the proportion of the former insufficient, he went on to the next tree, the result being that through the hole rot set in. This destructive practice has only been discontinued in one Province."

Whilst the Forester's time has been occupied in vain attempts to control the export of timber, works of reproduction and improvement have been neglected. Although rules were issued for clearings of inferior wood, and introduction of better species, it is said that no systematic work has been done, for want of funds.

A few cheenas have, however, been sown with teak, in the same way as in the Burma toungya plantations, and some small teak plantations made under Dutch rule still remain. Of these old Dutch plantations, of which there was formerly a considerable area, some have been cleared and absorbed in surrounding properties, others have been sold, and generally the trees now standing are only seedlings or stool shoots from the trees originally planted. One of these plantations is leased annually for Rs. 2-8 per annum, the branches being lopped and burned to manure the ground. The trees still standing are of all sizes up to 5 feet in girth, and one of the plantations has been claimed by the Sinhalese by right of 50 years' occupation.

There are other more recent teak plantations, but the soil is generally unsuitable and the plants inferior, the best results having been obtained in the Puttalam plantation in the North-Western Province, regarding which Mr. Vincent states :—

"In the North-Western Province, two miles inland from Puttalam, the Forester planted, in 1880 and 1881, 8 acres with teak, chiefly 6 feet apart. An additional 4 acres has now been cleared. The soil is a light sandy loam. The clearing is surrounded by forest, and as long as that stands, is well protected from the wind. The rainfall is 45 inches. The cost of clearing the original forest has been Rs. 30 an acre: this has been met by savings made by the Forester during four years from his transport allowance. The nursery work and planting out have been done at odd times by the Forester's depôt and baggage coolies, with some assistance from prisoners in the Puttalam jail and poll-tax defaulters. The trees have grown very well, those of 1880 being 23 feet high, but straggling and ill-shaped, having been planted 12 feet apart. The five months' seedlings put out in November 1881, 6 feet apart, are now 12 feet high; all are very healthy and completely cover the ground. As the work may be said to have been carried out without extra expense to Government, Mr. Maggiolini having at a sacrifice of his personal comfort kept down his travelling expenses, it appears most creditable that he should have succeeded in making the first really successful teak plantation in Ceylon, in a position where its unlimited extension is possible, although scarcely advisable. The soil and climate are not suited for growing fine timber, and when the trees reach the height of the surrounding forest the upward growth will probably stop."

The results of the teak cheenas is given as follows :—

"*Pulukanáwa.*—The best teak cheenas in the Eastern Province are near Pulukanáwa tank. In the earlier attempts, in 1876, the teak seed was sown when the cheena was cleared with the Indian corn crop, and no maniok or plantains were allowed. In 1877 and 1878 some land was sown as the plantain crop was dying down. The soil is bad—gravelly and sandy loam of no great depth, and having been thoroughly exhausted by the crops, is now covered with illuk grass and venangu stool shoots. The trees are unequal, and they have generally a rather stunted appearance. Those sown in 1876 are 20 to 25 feet high, 1 foot 3 inches to 1 foot 7 inches in girth; the younger trees are 20 feet high, and of 12 inches girth."

Regarding the reserved Government forests, we read as follows :—

"*Reserved Forest Lands proclaimed under the Timber Ordinance.*—Under Ordinance No. 12 of 1840, and under the present Timber Ordinance, various forests have at different times been proclaimed in the *Government Gazette* as *Reserved forest lands*, in which either no timber may be cut for any purpose whatsoever, or in which no valuable wood may be cut for agricultural implements. These forests are situated in the Western, North-Western, Southern, and Central Provinces.

"*Other Reserves.*—There are also so-called reserves, which are not proclaimed as reserved forest lands under the Ordinance, but are held by the Government Agent as reserved owing to some circumstance, such as their being village grazing lands, &c., rendering their sale inadvisable.

"Although the two classes of reserved forest would appear to be quite distinct, there is little real difference between them. When reserved forest lands are proclaimed under the Ordinance, the Kóralé or Pattu, the name of the forest, its situation and area are usually specified as sent in by the native headman."

The value of these reserves may be calculated when it is stated that they have not been demarcated, and in only one or two instances was Mr. Vincent able to ascertain their situation.

Mr. Vincent gives some interesting information regarding the land sales, which we give as follows :—

"I would briefly draw attention to the ill-considered plan on which land sales have hitherto been conducted, and their prejudical effect *on the timber supply and on the Crown forest revenue.* It has been shown elsewhere that the area of Crown land sold between 1833 and 1880 amounted to 1,177,086 acres, the total sum realized being £1,871,689, or an average of over 31*s.* an acre. The system has been to sell to the highest bidder any land applied for, the sale being free of all claims and conditions as to cultivation. No thought was given to climatic reserves until 1873, when, owing to Sir Joseph Hooker's representations, some areas in the Central Province at high elevations were saved. The reservation of forests for fuel or timber has likewise been treated with the same neglect. The principle has been that all considerations must give way, as Sir William Gregory states,*

* Sessional Paper No. XIX. of 1873.

in order to swell the revenue; to allow land in the most accessible places to be sold at the upset price of £1 per acre, when a small portion of the timber repays the cost of the land. We find, in consequence, that the forests in the most favorable position in the Western and Southern Provinces have been bought at the upset price of 5*s.* 3*d.* to £1 an acre, when at the time of purchase the timber alone must have been worth many times the price paid. Within the last few years strips of forest along the navigable streams in the Western Province have been bought solely for the standing timber, the result being that the native timber traders command the market, their forests along the river banks possessing greater facilities of transport than we have in the Crown forests standing further back.

"Under the system by which land is now sold, from first to last the opinion of the Forester is not called for; it is considered unnecessary to ascertain, by means of a reliable official what effect the sale of the particular block will have on the surrounding land. Whether the land is covered with fine timber forest or low scrub appears to be of no concern, as also whether an isolated block or a part of a large and valuable forest. I believe no measures are taken in the survey to give any but a plan of the block; its relative position to other blocks, to roads, rivers, villages or forests is not shown, nor is the plan accompanied by any report as to the vegetation, soil, standing timber, &c., which the surveyor might easily draw up, so that Government has, in reality, no data as a guide in according or refusing sanction to the sale.

"To show the facility with which land can be bought even in direct opposition to the authorities, I need only offer two instances. In the Eastern Province, since forest land has been no longer given for cheenas, the Mohammedan cultivators have attempted to buy it, ostensibly for paddy cultivation, at the upset price of Rs. 10 an acre. In one case, application was made for a 25-acre block near Pulukanáwa tank. A Surveyor was sent out, and in addition cut out a 50-acre block in the centre of a large area of virgin forest. Captain Walker, the Forester, happening to meet the Surveyor on the spot, and seeing what damage might be caused, was able to get a fair reserve price of Rs. 50 an acre put on the larger block, the natural result being that it was not sold. Similarly, a great deal of forest near Devilané was sold for the upset price, payable in instalments. The three years' rotation of cheena crops have been taken off the soil, and it is now covered with illuk grass only, from which fires year after year spread into the surrounding forests.

"In the Colombo District, where so little forest remains, it was only by chance that the sale of 700 acres of the best forest near Hanwella could be stopped. Availing himself probably of the temporary absence from the Island of the Hon. F. Saunders, an individual who had previously bought large areas of forest land for the timber only, applied for and got this large block surveyed. Had I not chanced to hear it in time to represent matters to the Colonial Secretary, the land would probably have been sold at the upset price, when at the lowest estimate the timber now standing may be valued at Rs. 150 an acre. The opening up of the country is no doubt desirable, but Government cannot be aware at what cost all other considerations are

waived, and for how slight a temporary augmentation of revenue the property of the Crown is being so rapidly diminished."

After giving an analysis of the cost of the forest management in Ceylon, Mr. Vincent sums up his conclusions regarding past work as follows :—

"In the Provinces where timber works have been carried out, the cost of establishments forms 28 per cent. of the gross expenditure. In the Southern and Central Provinces it forms 65 per cent. For the *whole of the Island, excluding the Western Province, the forest es*tablishments have cost 52 per cent. of the total outlay.

"To sum up the foregoing remarks, it will be seen that forest management has in the past only been a partial success.

"The want of a well-organized system of forest administration has made itself felt as regards—

The Area of the Forests and their Condition—

"By great destruction through cheena cultivation, owing to the absence of a proper law for protecting Crown lands;

"By great diminution of area, in the sale of the best forest lands in the most accessible positions at nominal prices, also causing a permanent depreciation in the value of other forest property;

"A neglect of all climatic and economic considerations, which *point to the formation of proper reserves in the hills and in the low* country;

"A continuance of the evils of the license system, allowing contractors to cut what and as they liked, and no change in the destructive habit of tapping ebony trees;

"An absence of all organized measures of forest improvement, such as thinning, planting, &c.;

(Financial Success and Economic Working).

"High working expenses, and absence of any arrangement between the Foresters as regards labour rates, &c.;

"The share system, by which the capital required for conducting forest works had to be borrowed by a native at 16 to 20 per cent., instead of being provided by Government from its cash balances, in*volving extravagant remuneration in kind for work done, great waste* of good material in the forest, and in addition affording great openings for theft;

"A total disregard of the laws of supply and demand, each Province endeavouring to bring the maximum quantity of wood to market;

"Large forced sales without any reserve price; *competition between* Provinces in having auctions on the same day, &c., &c.;

"Over-measurement in making sales;

"A neglect to develope the forest resources by bringing new products to market;

"An absence of any effectual measures for controlling timber transit, &c."

(To be continued).

THE

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It was with great pleasure, that, in the New Year's *Gazette*, we noticed Mr. B. H. Baden-Powell's name amongst the list of newly appointed Companions of the Indian Empire. His connection with the Forest Department extended from 1869 to 1881, during which time, besides being engaged on special work regarding timber frauds to the extent of 3 or 4 lakhs of Rupees in Burmah, he was Conservator of Forests in the Punjab from 1869 to 1872, and from 1876 to 1879, and Officiating Inspector General of Forests to the Government of India during 1873-74. He was on special duty with the Government of India in 1879-81 to study revenue law and land-tenures, and to advise regarding the Madras and Burmah Forest Acts. He was associated with Dr. Schlich as joint Editor of the "Indian Forester" in 1875.

But his best known work has been the compilation of the very useful Manuals of Indian Land Revenue and of Forest Jurisprudence.

He is at present Additional Commissioner in the Punjab, where he lately officiated as Judge of the Chief Court, and we wish him every success during the remainder of his career in India.

SHORT NOTES ON THE NURSERY TREATMENT OF DEODAR AND OTHER TREES, AT RANIKHET.*

Deodar.—In this country deodar is best sown soon after the seed ripens, or early in December. The ground for seed beds should be light loam, or what is termed good garden soil. Heavy clay soil, which binds in wet, and cracks under the hot sun of April and May, should be avoided. The ground should not be manured, only carefully hoed, 15 inches or 18 inches deep, and levelled, and the seed sown in broad *shallow* drills 8 inches apart. Should the spring prove dry, the beds will require to be watered before the seed germinates, but this is not always

* The greater portion of these useful notes were written in 1875 and published officially. We reprint them, as they embody the results of long and mature experience.—[Ed]

necessary. When the seeds germinate and water is required, it is better to give a good copious watering once in two or three days than a little every evening, the good effects of which is quite nullified by the next day's sun. By July the young plants are sufficiently large to handle, and should then be transplanted in nursery lines 9 inches apart and 6 inches in the lines. This work is best performed by stretching a line and cutting along it a trench with a hoe or a spade, and against the smooth surface of the bank (which should be as perpendicular as possible) thus formed, the young plants are placed and supported by a handful of earth, care being taken to first fully extend their roots against the bank. The remainder of the earth being then replaced and levelled. This is much better than transplanting by dibble, the hole made by which is frequently too shallow, the roots are thereby curled up, and the plant makes no progress.

By next rains the plants must again be transplanted in lines 15 inches apart and 1 foot in the lines, care being taken to remove them with a little ball of earth adhering to their roots. The same care must be observed to fully extend their roots in the trench, and the ground should be pressed firmly about the roots to steady the plant. The plants soon establish themselves, and nothing further is required than to keep them free from weeds. By the following rains, the third year from sowing, the plants are ready for removal to the forests.

The seedlings sent over to Naini Tal (distance 30 miles) are taken up without any of the original earth adhering to the roots, and immediately packed in baskets, a little earth being placed round and among the roots to prevent drying up on the way. I send over plants of all ages, from 3 to 6 or 7 years' old, but the older seedlings have undergone frequent transplanting in the nursery. It is not safe to send old deodar far, if more than 18 months have elapsed since the last transplanting.

CHIL, (*Pinus excelsa.*)—The same treatment as for deodar applies to this tree in the nursery.

CHIR, (*Pinus longifolia.*)—The seed of this tree does not ripen until March or April according to situation. Sow then and transplant as directed for deodar.

BAN-OAK, (*Quercus incana.*)—Collect acorns early in December; gather from the tree, and not those that have fallen, which are generally worm-eaten. Any ordinary good soil, prepared as directed for deodar, will suffice for the oak. Sow like peas in broad drills a foot apart and 3 inches deep, keep free from weeds during the summer rains. During the *second* rains from sowing take up the young plants, lightly trim their roots, and transplant in lines 15 inches apart and 9 inches in the lines. Again weed and occasionally stir the surface of the soil, and during the following rains remove to the forest if the planting is near at hand; if very distant, again remove into nursery lines in

rather poor soil, and transplant in the forest next rains. Oak succeeds best when transplanted during the rainy season.

HORSE-CHESNUT, (*Æsculus indica.*)—Soon after the seed ripens, in November or December, sow in good rich soil in drills a foot apart, 3 or 4 inches deep, the seeds 6 inches apart. Keep free from weeds during the rains, and when the young trees shed their leaves in the cold weather take them up, lightly trim their roots and transplant in good soil, in lines 18 inches apart and 1 foot in the lines. Occasionally stir the surface of the soil during the hot weather. No watering is required; keep free from weeds. In the cold weather the plants are fit for removal to the forests. They should be taken up without any earth adhering to their roots, which, in the case of distant planting, is a convenience and saving.

WALNUT, (*Juglans regia.*)—The same treatment of sowing, pruning the roots and transplanting, as directed for the horse-chesnut, applies to the walnut. These trees, in fact all deciduous trees, are best transplanted during the cold weather.

ALDER, (*Alnus nepalensis.*)—This should be sown at the end of February or beginning of March in very shallow drills, a foot apart, on level ground. After sowing, the ground should be covered lightly with fern or grass and watered occasionally until the seed germinates, after which gradually remove the covering, and weed, water and stir the soil as directed for deodar. During the following cold weather take up the seedlings, trim their roots with a sharp knife and transplant in lines as directed for horse-chesnut and walnut. The plants, as in the case of horse-chesnut and walnuts, are fit to remove to the forest the second cold weather from time of sowing.

ACACIA.—Choose a good friable soil which, when dry, dig about 18 inches deep. If the land is not level, it should be formed into small terraces according to the lie of the ground, and across the terraces make beds 4 feet wide with 18 inch paths between. Sow in fine weather, early in February, in shallow drills across the beds and 8 inches apart. If the weather proves dry the beds must be well watered, as directed for deodar, and when the young plants appear they should be kept free from weeds and the soil between the drills frequently stirred with a small Dutch or draw-hoe. All watering, weeding and hoeing should be performed from the paths, and the beds not needlessly trod upon. By the middle of July, being then 6 inches to a foot high, the seedlings will be ready to transplant. Any ordinarily good ground, level or sloping, will do to transplant in, but care should be taken to avoid places subject to severe hoar frost. Take up the seedlings, line by line, with a digging fork, separate them into two sizes, and plant the largest in one plot in lines 15 inches apart and 1 foot in the lines; the smaller plants put on another plot in lines 1 foot apart and 9 inches in the lines, and afterwards keep free from weeds. By the follow-

ing rains the plants will be ready to remove to the forests or plantations.

EUCALYPTUS.—Sow as directed for Acacias.

About the middle of July take up the seedlings, separate them into two sizes, and plant as directed for Acacias, and, as in their case, also carefully avoid low damp places subject to severe hoar frost. Choose wet days for the work, and, when the plants are established and weeds appear, hand-weed the lines, or, if a few fine days occur, first lightly hoe between the lines. Never allow weeds to over-top the plants, or they will be drawn up, weakly and be unable to withstand the winter without protection. By the following rains the plants will be ready to remove to the plantations. If the plants are required for very exposed situations, instead of sowing the seeds in February, defer it till July, and then sow in sandy or gravelly soil, sloping gently to the east. Line off the beds across the slope, inclining a little one way for the paths to carry off heavy rain. The beds should not be level but sloping like the land, and raised a few inches, by means of the earth taken from the paths. Sow the seeds in very shallow drills across the beds, and when the young plants appear keep them free from weeds. About Christmas, or when snow is apprehended, cover the beds with grass tatties, raised 18 inches from the beds. This covering should remain until the middle of February, or later if the locality is very cold and exposed. If the spring is dry, well water the beds three times a week, or oftener if necessary, occasionally stirring the soil between the drills to prevent its caking; and, when the rains set in, take up the seedlings, separate them into sizes and plant as directed for spring-sown ones. Afterwards keep the plants free from weeds and remove to the plantations the following rains.

Unless the soil and situation are very favorable, the several kinds of gums should not be planted over 6,000 feet. Above this height they are liable to be broken by heavy snow lodging upon their tops and branches and weighing them to the ground. This year at Dúnágiri, at an elevation of 6,500 feet, two large blue gums, 10 years' old and over 60 feet high, were broken short above the ground by snow lodging upon them, younger plants of the same variety at a similar elevation at Ranikhet were also broken, while leafy plants of the same kind, 5 years' old, at an elevation under 6,000 feet, escaped, their leaves being smaller and not so dense. Acacias are not so easily broken, and may therefore be planted at a slightly higher elevation than that recommended for the Gum, but care should be taken in planting either tree to avoid damp dells or flats subject to severe hoar frost. Of Gums, the blue and iron bark (*Eucalyptus globulus* and *Sideroxylon*) are the best sorts to plant in the hills; and of Acacias, *decurrens* and *Melanoxylon*.

W. CRAW.

TO MAKE CHARCOAL.*

THE best sized wood for this purpose is of the form understood as billets. An ordinary kiln for smelting measures 18 feet in diameter, and requires about 25,000 billets, cut as nearly as possible of the same length. Procure a pole about 25 feet long and 6 to 8 inches *thick, straight,* and *of uniform thickness.* Provide yourself with four forked sticks of the shape of *Fig.* 1. Erect the pole perpendicularly on the spot where the kiln is to be made, and place the four forked sticks round it, arranging pieces of wood from fork to fork and across, to make a hollow space in the centre of the kiln, of about 18 square inches, as in *Fig.* 2, for containing combustible matter. Provide the person stacking the billets with a yard measure, and with one end of the measure against the pole, let him sit at the other end and place the billets in an almost perpendicular position against the cross pieces, and as close *together as possible, each coolie stacking* right and left to join his neighbour's work on either side. Thus he goes on stacking until he has come to the end of his measure; all having done the same, a perfect circle will be the result. After having filled up with brushwood or old charcoal all interstices there may be from crooked or large billets, each coolie pulls out his measure to another yard in length and proceeds as before. Having done this the third time, the kiln will measure 18 feet in diameter. The coolies then mount the first layer of billets and commence stacking from the pole, until they come to *the end of the second layer, making an allowance for* the curve, and so on a third and fourth layer, until the kiln is completed, as shown in *Fig.* 3. Cover in the whole kiln with turf, 3 to 5 inches thick, turning the grass side inwards, commencing from the bottom; after which throw a small quantity of loose earth over the turf, beating it down with the back of a spade; if turf is not procurable, put a compact layer of earth over leaves and brushwood, moistened with water.

After the whole kiln has been covered in, let one or two men ascend and pull out the pole, leaving an empty space from top to bottom. *From the top, drop in a ladle full of ignited char*coal, and immediately this is done, open out one turf at the bottom of the kiln, say at A. This will cause a draught of air in the direction of ADC, *Fig.* 4, and in a few minutes, dense smoke will be seen ascending at C, and vapour condensing on the coating, after which flames will burst forth. Let this continue for five or ten minutes, till it is clear that the billets in the centre of the kiln are on fire, when a man must be sent up with a large turf to close the opening at C, over which he

* The above paper was found amongst the Dehra Dún office records, and has been reprinted here for the benefit of readers of the "Indian Forester;" it is not dated.—[ED.]

should sprinkle earth to keep in all flame, and secure uniform combustion in all parts of the kiln. *From this moment no flame must be allowed to escape from any part of the kiln.* When the opening at C has been closed, one at B should be made. The billets in the direction of DA and DB will then ignite faster than any other, and when smoke is seen escaping between every turf in the direction of AC and BC, the openings at A and B must be closed and fresh ones made, say at E and F; these will be closed in their turn and others made at G, H, I, and J, *Fig.* 5. Shortly after this, smoke will be seen to issue uniformly from every crevice, when all air holes at the bottom must be closed. After the charring is complete, the whole kiln will fall in at the end of two or three days, according to size, and assume something of the shape in *Fig.* 6.

Earth must then be thrown on with shovels to *extinguish all smoke*, and at the end of 36 hours, the charcoal may be raked out. A few buckets of water should be in readiness, if required to put out the sparks of fire which may remain.

Great care must be taken to stop every fissure in the casing, and if from bad management the heap settles, and the casing falls in at any part, the cavity must be filled up with green wood kept ready for the purpose, and the covering replaced. As soon as the dense smoke ceases, and the wood burns with a light transparent smoke, the whole must be closed in and watched, lest any fissures appear.

In burning in pits, vent-holes are made in the sides, and the covering of sods being of smaller extent, is easily formed, and the wood is more conveniently packed, as shown in *Fig.* 7; the logs in the middle of the lower course should be dry with a few chips and refuse charcoal from former kilns among them.

Sometimes, it may be convenient to form a kiln by digging out the side of a hill, (*Fig.* 8,) but in all cases the system is the same. If the process is properly conducted, the bulk of charred wood is not greatly reduced.

In climates where vegetation is rapid, it is not necessary to cut down trees for charcoal, but merely to lop off lower branches; refuse wood should be used in the manufacture, and dry wood is superior to wet, as it splits more easily and saves labor. On dry forest land, a crop of wood sufficient for charcoal can be obtained every fifth or sixth year, and on marshy land, every third year.

Some woods are better suited for the purpose than others. Hard woods, with a close grain, make the best charcoal; in England, oak, elm, beech, and ash, are generally used. The following abound in many parts of India, and amongst others have been found suitable for the manufacture :—

Sál, *Shorea robusta.*	Kheir, *Acacia Catechu.*
Sissú, *Dalbergia Sissoo.*	Teak, *Tectona grandis.*
Kikar, *Acacia arabica.*	Nim, *Azadirachta indica.*

TO MAKE CHARCOAL.

FIG. 1.

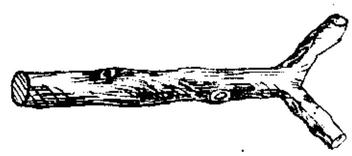


FIG. 2.

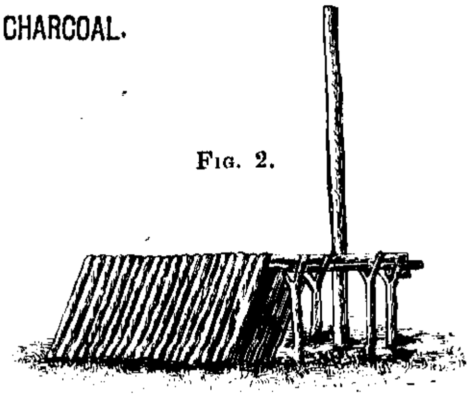
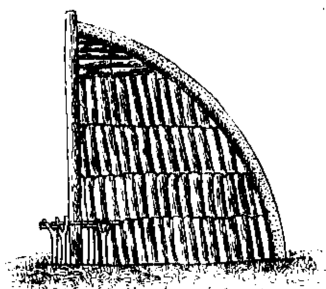
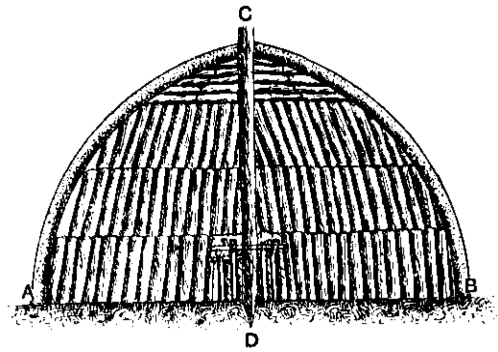


FIG. 3.



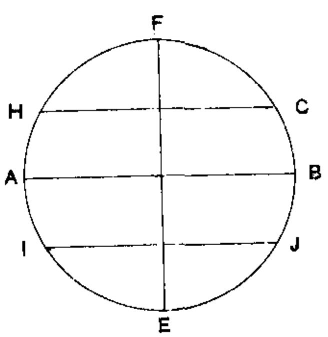
Section of one-half of the Kiln.

FIG. 4.



Vertical Section of Kiln.

FIG. 5.



Horizontal Section of Kiln.

FIG. 6.

FIG. 8.

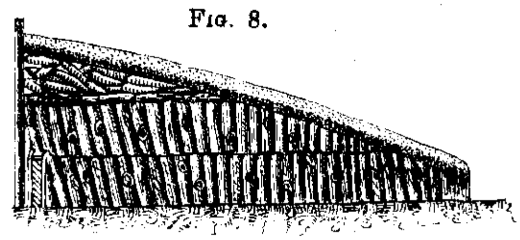
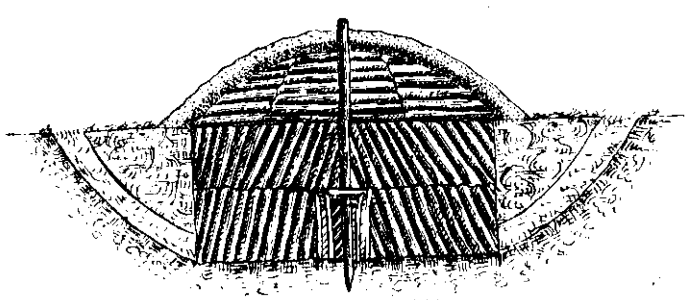


FIG. 7.



Section of a Charcoal Pit.

Litho. T. O. Press, Roorkee.

THOS. D. BONA, *Supdt.*

Sandun, *Oojeinia dalbergioides.*	Box, *Buxus sempervirens.*
Lohira, *Tecoma undulata.*	Oak, *Quercus incana.*

Soft woods with an open grain and quick growth are not so well adapted for making furnace charcoal: white and resinous woods are seldom used. The comparative value of Indian hard woods in charcoal making is an interesting subject of inquiry, and careful experiments to determine the best sorts of timber for special purposes are required: the proportionate produce from 1000 parts of several kinds is given by Brande, as follows:—

Ebony, ...	300	Box, ...	202
Satin wood, ...	207	Fir, ...	181

The Beypore Iron Company, I believe, find the loppings and thinnings of the teak plantations in Malabar specially adapted for smelting purposes, and in a short time the prunings of sissú, &c., in the canal plantations of the Punjab and North-West Provinces may be equally valuable. The utilising of thinnings and of refuse timber is urged upon all Forest officers.

The economic preparation of charcoal at the different hill stations is most important, and the best mode of initiating it, is to collect the charcoal burners and to give them practical instruction by firing a small kiln in their presence. The outturn of slow charring is so much larger than that obtained by their rude process in open pits, that they will generally be found to adopt the principle of a closed kiln. In several experiments in the Himalaya, where the common Ban oak (*Quercus incana*) was used, one-third more in bulk was obtained than by the common method, and the charcoal was in larger pieces, heavier, and well charred. Wicker baskets, being elastic, do not break the charcoal and are generally used for transport.

H. Cleghorn,
late Conservator of Forests.

INTERNATIONAL FORESTRY EXHIBITION,
Edinburgh, 1884.

We give below the list of subjects for prize essays at the Edinburgh Forestry Exhibition, and hope, for the honor of the Indian Forest Department, that some of our readers will compete.

ESSAYS AND REPORTS.

Concise Practical Essays on the subjects enumerated below would be much appreciated, and would assist the labours of the Jurors and Reporters.

Systematic Collections of Forest Produce, specially illustrating the sources of Supply and the methods of Manufacture in different Provinces, with accompanying Reports, are solicited.

Any such Reports or Collections must be forwarded direct to me on or before 14th June, 1884, and they will be immediately acknowledged and referred to the several Sections.

Diplomas, Medals, and Money Prizes will be awarded on the recommendation of competent Jurors.

1. On the Formation and Management of Forest Nurseries.
2. On the Formation and Management of Plantations in various Sites, Altitudes, and Exposures.
3. On the Present and Prospective Sources of the Timber Supplies of Great Britain, with Statistics of the various descriptions of Timber Imported during the past 25 years.
4. Report, with Specimens, of any Hard Wood likely to supply the place of Box Wood for Wood-engraving.
5. On the Afforesting of Mountains and other Waste Lands, with details of the method adopted and the results obtained. To be accompanied with Drawings, Photographs, or Models.
6. On the effects of Forests on Humidity of Soil and Climate, from personal observations made by the Author in any Country or Locality.
7. On the Treatment of Coppice and the Utilisation of Branches and Fragments of Forest Produce, with the view of diminishing waste.
8. On the Growth and Management of Eucalyptus Plantations, and their economic uses.
9. On the best Method of preventing Erosion of River Banks, with Illustrations.
10. On the comparative advantages of the various Methods of producing and harvesting Cinchona Bark, with Specimens.
11. On the ravages of Tree and Timber destroying Insects, with Specimens and Illustrations.
12. On the ravages of Mollusks and other Marine Timber destroying Animals (excluding Insects).
13. On the Destructive Influence on Wood of Fungi and other Plants.
14. On the Supply of Teak Wood for Ship-building purposes.
15. On the Utilisation of Forest Produce in the manufacture of Paper.

The Executive Committee are anxious to obtain Reports on the Forest Productions of our own Crown Colonies or Foreign Countries, accompanied by Specimens.

George Cadell, *Secretary*,
3 George IV. Bridge, Edinburgh,
(*Late Indian Forest Department*).

IV. Notes, Queries and Extracts.

THE PREPARATION OF RHEEA FIBRE.

One of the most important economic questions that has presented itself for solution of late years is the utilisation of the rheea, or China grass plant—which is also known under the name of ramie—for textile purposes. And the importance of that question becomes national when considered in connection with our Indian and Colonial possessions. The difficulty in solving the question has not lain in the cultivation of the plant, for that point has long since been settled. Within certain limits rheea can be grown in any climate, and India and the British colonies offer unusual facilities, and present vast and appropriate fields for that enterprise, while it can be, and is, grown in most European countries. All this has long been demonstrated; not so, however, the commercial utilisation of the fibre, which up to the present time would appear to be a problem only partially solved, notwithstanding the time, thought, labour, and capital expended upon it. The difficulty has lain in the decortication of the stems of the plant, and four times during the present century official action has been taken by the Government in the endeavour to elucidate the question. The first effort for utilising the plant dates from 1803, when Dr. Roxburgh started the question, and the second from 1840, when attention was again directed to it by Colonel Jenkins. The third attempt in this direction was made in 1869, when the Indian Government offered a reward of £5,000 for the best machine for separating the fibre from the stems and bark of rheea in its green or freshly cut state. The Indian Government was led to this step by the strong conviction, based upon ample evidence, that the only obstacle to the development of an extensive trade in this product was the want of suitable means for decorticating the plant. This offer, however, led to only one machine being submitted for trial, although several competitors had entered their names. This apparatus was that of Mr. Greig, of Edinburgh, but after careful trial by General (then Lieutenant-Colonel) Hyde it was found that it did not fulfil the conditions laid down by the Government, and therefore the full price of £5,000 was not awarded. In consideration, however, of the inventor having made a *bonâ fide* and meritorious attempt to solve the question, he was awarded a donation of £1,500. Other unsuccessful attempts were subsequently made, and eventually the Government found themselves obliged to withdraw

the offered prize. This, however, was only for a time, for invention was still rife in this direction, and in 1881 the Government re-offered the £5,000. Another competition took place, at which several machines were tried, but the trials, as before, proved barren of any practical results, and up to the present time no machine has been found capable of dealing successfully with this plant in the green state.

The withdrawal of the stimulus, however, does not appear to have damped inventive ardour, for the subject was still pursued in many directions. Nor can we wonder at this when we remember the value of the fibre as regards strength. This was shown in the case of some rheea fibre from Assam experimented with in 1852 by Dr. Forbes Royle, which, as compared with St. Petersburg hemp, was in the ratio of 280 to 160, while the wild rheea from Assam was as high as 343. But, above and beyond this, rheea has the widest range of possible applications of any fibre as shown by an exhaustive report now before us on the preparation and use of rheea fibre by Dr. Forbes Watson, published in 1875, at which date Dr. Watson was the reporter on the products of India to the Secretary of State at the India Office. Amongst the fibres which already enter largely into textile manufactures, flax is perhaps the one which possesses the most extended range of application—from the roughest canvas and cordage to the finest lace; yet the range of rheea is even greater still. Dr. Watson points out that this is due partly to the superlative degree in which it possesses certain qualities, such as fineness, strength, and lustre, not usually associated in the same perfection in any single fibre, and partly to the curious intermediate position which it holds between the usual vegetable and animal fibres. Although a vegetable fibre, its hairiness assimilates it to wool, and its gloss and fineness to silk. The resemblance to wool rheea shows in common with other nettles—the Neilgherry nettle, for instance, which is, however, so very rough and hairy that it could never compete with smooth fibres such as flax, whereas rheea can be rendered fit for either use. Thus rheea combines the whole range of applications of hemp, to which it is superior in almost every respect, with almost the whole range of the uses of flax, excepting, perhaps, its use for body linen, together with certain other uses for which only the animal fibres, wool and silk, have hitherto been employed. Amongst others who have sought to render China grass available for the spinner is M. A. Favier, and he succeeded about a year ago in solving the question of decortication in the green state in a satisfactory manner. M. Favier's process—the experiments with which were reported by us at the time*—consists in subjecting the plant to the action of steam for a period varying from ten to twenty-five minutes

* *Vide* IRON, Vol. XX., page 80.

according to the length of time the plant has been cut. After steaming, the fibre and its adjuncts were easily stripped from the wood. The importance and value of this invention will be realised when it is remembered that the plant is cultivated at long distances from the localities where the fibre is prepared for the market. The consequence is that for every hundred weight of fibre about a ton of woody material has to be transported. Nor is this the only evil, for the gummy matter in which the fibre is embedded becomes dried up during transport, and the separtion of the fibre is thus rendered difficult and even impossible, inasmuch as some of the fibre is left adhering to the wood. It will thus be seen that M. Favier's process greatly simplifies the commercial production of the fibre up to a certain point, for, at a very small cost, it gives the manufacturer the whole of the fibre in the plant treated. But it still stops short of what is required in that it delivers the fibre in ribands with its cementitious matter and outer skin attached. To remove this, various methods have been tried, but, as far as we are aware, without general success—that is to say, the fibre cannot always be obtained of such a uniformly good quality as to constitute a commercially reliable article. The fact is, attention has been too largely given to mechanical methods of manipulation and too little to chemical processes.

Seeing, then, that decortication had been successfully accomplished without the aid of machinery, it occurred to Messrs. G. W. H. Brogden & Co., of Gresham House, London, who had interested themselves in M. Favier's invention, that the process of utilisation might be carried forward in a similar manner—that is, without mechanical aid. To this end, they submitted the matter to the distinguished French chemist, Professor Frémy, Member of the Institute of France, who is well known for his researches into the nature of fibrous plants and the question of their preparation for the market. Professor Frémy thoroughly investigated the matter from a chemical point of view, and at length brought it to a successful and what appears to us, on investigation, to be a practical issue. And here we may observe that one great bar to previous success was the absence of exact knowledge as to the nature of the constituents of that portion of the plant which contains the fibre, or, in other words, the casing or bark surrounding the woody stem of the rheea. Professor Frémy therefore commenced to investigate in this direction, and, as determined by him, the casing consists of the cutose, or outer skin, within which is the vasculose containing the fibre and other conjoined matter known as cellulose, between which and the woody stem is the pectose or gum which causes the skin or bark as a whole, fibre included, to adhere to the wood. The Professor next proceeded to ascertain the nature of these various substances, and in the result he found that the vasculose and pectose were soluble

in an alkali under certain conditions, and that the cellulose was insoluble. He then sought a method of releasing the fibre from its imprisonment, which object he effects by dissolving out the cutose, vasculose, and pectose by a very simple process, obtaining the fibre clean and free from all extraneous adherent matter and ready for the spinner. In order, however, to ensure as a result *a perfectly uniform and marketable article*, the Professor uses various chemicals at the several stages of the process. These, however, are not administered haphazard or by rule of thumb, as has been the case in some processes bearing in the same direction, and which have consequently failed in the sense that they have not yet taken their places as commercial successes. Professor Frémy therefore submits the plant which he has to treat, to careful examination, and, according to its nature and the character of its components, he determines the proportions and nature of the various chemicals to be employed at the several stages. *The possibility of failure* thus appears to be eliminated, and the production of a fibre of uniform and reliable quality, no longer remains a matter of chance, but is rendered a comparative certainty. The success of the two processes of M. Favier and M. Frémy having been assured experimentally, it was determined to combine their working in one continuous operation. Machinery was therefore put up in France on a scale sufficiently large to fairly approximate to practical working, and to demonstrate the practicability of the combined inventions. The experimental works are situated in the Route d'Orleans, *Grand Montrouge, just outside Paris*, and a series of demonstrations were recently given there by Messrs. G. W. H. Brogden & Co., of Gresham House, London. The trials were carried out by M. Albert Alfroy under the supervision of M. Urbain, who is Professor Frémy's Chief Assistant and Co-patentee, and were attended by Dr. Forbes Watson, Mr. C. E. Collyer, Mr. C. J. Taylor, late Member of the General Assembly, New Zealand, Mr. Healy (lately from India), M. Barbe, M. Favier, Mr. G. Brogden, Mr. Casper, Mr. Perry F. Nursey, C.E., and a number of other gentlemen representing those interested in *the matter under consideration.*

The trials extended over several days, and were most interesting, involving as they did the combined processes and their application to rhea grown in France and England. The French plants treated were grown at La Reolle, near Bordeaux, whilst the English specimens were grown at Strathfieldsaye by the Duke of Wellington, who has taken an active interest in the question at issue for some years past. The English rhea was taken by Dr. Forbes Watson, who carried out some special experiments with it. One of the objects of Dr. Watson's experiments was, by treating rhea *cut at certain stages of growth, to* ascertain at which stage the plant yields the best fibre, and consequently how many crops can be raised in the year with the

best advantage. This question has often presented itself as one of the points to be determined, and advantage has been taken of the present opportunity with a view to the solution of the question. Mr. C. J. Taylor also took with him a sample of New Zealand flax, which was successfully treated by the process. In all cases the rheea was used in its green state and was comparatively freshly cut. As carried out at Montrouge the process consists in first treating the rheea according to M. Favier's invention. The apparatus employed for this purpose is very simple and inexpensive, consisting merely of a stout deal trough or box about 8 feet long, 2 feet wide, and 1 foot 8 inches deep. The box has a hinged lid and a false open bottom, under which steam at a low pressure is admitted by a perforated pipe, there being an outlet for the condensed water at one end of the box. Into this box the bundles of rheea were placed, the lid closed, steam turned on, and in about twenty minutes it was invariably found that the bark had been sufficiently softened to allow of its being readily and rapidly stripped off by hand, together with the whole of the fibre, in what may be called ribands. Thus the process of decortication is effectively accomplished in a few minutes, instead of requiring, as it sometimes does in the retting process, days and even weeks, and being at the best attended with uncertainty as to results, as is also the case when decortication is effected by machinery. Moreover, the retting process, which is simply steeping the cut plants in water, is a delicate operation, requiring constant watching, to say nothing of its serious inconvenience from a sanitary point of view on account of the pestilential emanations from the retteries. In fact, retting is considered by some as wholly inapplicable to rheea, as the fermentation is so rapid and energetic that it may easily become destructive to the fibre. Moreover, the tops of the items are much more tender than the lower and more woody portions, so that the upper parts stand a chance of being over-retted, and the fibre entirely spoilt before the lower thicker woody sticks have been attacked by fermentation. The same difference may also occur in the stems themselves, some in the same crop being slender and succulent, whilst others are much more fully developed and woody. But to return to the process, decortication by steam having been effected, the work of M. Favier ceases, and the process is now carried forward by M. Frémy. The ribands having been produced, the fibre in them has to be freed from the surrounding mucilaginous secretions. To this end, after examination in the laboratory, they are laid on circular metal trays, which are placed one above the other a short distance apart in a vertical perforated metal cylinder. When charged this cylinder is placed within a strong iron cylinder containing a known quantity of water, to which an alkali is added in certain proportions. Within the cylinder is a steam coil for heating the water, and, steam having been turned on, the tem-

perature is raised to a certain point, when the cylinder is closed steam-tight. The process of boiling is continued under pressure until the temperature—and consequently the steam pressure—within the cylinder has attained a high degree. On the completion of this part of the process, which occupies about four hours, and upon the careful carrying out of which the success of the whole mainly depends, the cementitious matter surrounding the fibre is found to have been transformed into a substance easily dissolved. The fibrous mass is then removed to a centrifugal machine, in which it is deprived of its surplus alkaline moisture, and it is then placed in a weak solution of hydrochloric acid for a short time. It is then transferred to a bath of pure cold water, in which it remains for about an hour, and it is subsequently placed for a short time in a weak acid bath, after which it is again washed in cold water, and dried for the market.

It is a very easy thing to watch and detail the various operations connected with this ingenious process, but it can afford no indication of the amount of time and labour, mental and physical, expended upon it in bringing it to its present successful issue. This indication, however, was afforded to those who followed the operations at Montrouge by a highly interesting visit to the government laboratory in Paris, of which Professor Frémy is Chief and M. Urbain *sous-chef*, and where those gentlemen explained the details of their process and made their visitors familiar with the progressive steps of their investigations. There they were shown the various constituents of the bark—taken as a whole—of the rheea, as well as numerous samples of the fibre produced by the processes we have described, many of which had the most delicate silky appearance. The visitors also proceeded to Louviers, near Rouen, where a factory has been acquired, in which there is machinery already erected for preparing the fibre according to the processes we have described at the rate of one ton per day. There is also machinery for spinning the fibre into yarns.

Such, then, are the means by which it is expected the China grass will be enabled to compete successfully with other fibrous plants. The results of the combined processes justify this expectation, being, so far as they go, eminently satisfactory. If generally adopted, they will not only enable the fibre to be produced at a much lower cost, and much better in quality than hitherto, but they will doubtless lead to the successful utilisation of vast tracts of eligible land for the cultivation of China grass, land upon which, up to the present, its cultivation would not pay on account of the heavy cost of transport from the field to the works. The successful issue would prove a boon to India and our Colonies, whilst the industry might also be pursued much nearer home owing to the adaptability of the plant to a wide range of climate. It appears to be the solution of a great

industrial problem, and we hope to see the new industry to which it points fully developed.

The problem of the mechanical preparation of rheea fibre—which is practically identical with China grass—has for many years past occupied the attention of engineers and inventors, but until very recently its solution appeared as far off as it was at the commencement of the present century, when the question was first taken up by the Government. Endeavours have long been made in various directions to utilise this plant for the production of textile fabrics, but without general success, owing to the difficulties attending its profitable decortication. Four times within the present century has rheea been the subject of official action, while within the last fourteen years a prize of £5,000 has been twice offered by the Indian Government, twice competed for, and twice withdrawn in consequence of all the mechanical means submitted for trial having failed to meet the requirements of the Government. We have, however, recently had an opportunity of inspecting the working of a machine which appears most effectually to dispose of the question. It separates the fibre from the woody stem of the green rheea, and at the same time cleanses it from all extraneous adherent matter, producing it in good condition for the market, and this without any previous or subsequent treatment. This machine is the invention of Mr. H. C. Smith, and is manufactured by Messrs. Death and Ellwood, of Leicester. It consists of a cast-iron framing about 3 feet high, 2 feet wide, and 3 feet deep from front to back, carrying a revolving drum about 18 inches in diameter and 12 inches wide. The drum is fitted with a series of beaters which pass near to the edge of a feeding table about 12 inches wide, the drum being covered in with an iron hood. From beneath the feeding table a thin sheet of water is made to play in a constant stream against the drum at a certain pressure and angle, and this constitutes the whole of the apparatus. The fibrous plants are fed in by hand on the feeding table, and are simply held up to the beaters by a cushion or backing of water, by which means the whole of the extraneous matter is removed, and the fibre produced in a remarkably short time and in excellent condition. The secret of success is undoubtedly due to the backing of water, which offers a yielding medium for holding up each and every fibre, individually, to the action of the beaters.

The machine has been invented about a year, and several have been made and sent out to India, where they are now doing good work upon various kinds of fibrous plants. It does not, however, appear to have hitherto occurred to anyone to try the effect of the machine in preparing the fibre of the rheea plant. This was probably on account of the woody nature of the rheea stalk, which, it might be assumed, would cause dam-

age to the fibre if the stalk were beaten in a machine running at a high velocity. A few weeks since, however, the machine was brought under the notice of Dr. Forbes Watson, who, from his long practical acquaintance with fibrous plants, at once conceived the idea that with the water backing it would successfully treat the rheea. He therefore at once put the machine to the test, and found that his surmises were correct, and that rheea fibre could be effectually produced in a simple and speedy manner. A private demonstration at which we were present was recently given at Messrs. George Jennings's Works, Stangate Wharf, Lambeth, upon which occasion there were present General Hyde, of the India Office, the Hon. Henry Berkeley, Mr. C. E. Collyer, and the representatives of some of the leading firms in the fibre trade. The experiments were conducted by Dr. Forbes Watson, and consisted primarily in the treatment of some rheea grown in England, as well as other stalks of rheea grown in France. It should be observed that in practice the rheea would be treated freshly cut and in its green and juicy condition. In the present instance, however, the English stalks were cut on the 30th of October, and although they had been as far as possible preserved green, they were not of course in a condition to justify the expectation of the best results. But notwithstanding this they were all successfully treated, the fibre coming out much better than had been anticipated. In one of the tests 115 stems of the French rheea were treated by the operator, and the fibre produced clean and free from all adherent articles in three and three-quarter minutes, thus showing the rapidity with which the work can be carried on. Besides the rheea several varieties of fibrous plants were put through the machine, including the *Fourcroya gigantea*, an Indian aloe, the *Sanseveira zeylanica*, or bowstring hemp, as it is called by the natives, the yucca, and the *Phormium tenax* or New Zealand flax. All these were successfully treated, and, considering that none of them were freshly cut, and that, moreover, they were garden specimens of the various species, the fibre left the machine in a clean and satisfactory condition. It was thus amply shown that the solution of the problem of the mechanical preparation of rheea fibre had been at length effectually solved. The opinion of several experts in the matter of fibrės was that the treatment of the rheea plant had been fully and fairly accomplished. The invention is in the hands of Mr. C. E. Collyer, of 141, Fenchurch Street, London, who showed the visitors some samples of fibre of the *Sanseveira zeylanica* and the *Fourcroya gigantea* which had been prepared by the machines in India and sent over in bales by Messrs. Staines and Co., of Coimbatore, Madras, and with which the fibre just produced from the same species of plant compared favourably, considering the unfavourable circumstances, already referred to, under which the demonstration was carried out.—*Iron.*

DEAD BRANCHES DETRIMENTAL.—I have been asked whether the statement lately going the rounds of the American papers that "a dead branch on a tree makes almost as great a strain on the main plant for moisture as does a living one" is accurate or not. The statement is coupled with another referring to its practical application in tree culture, the conclusion being that every dead branch "should be at once cut away." Briefly it might be answered that the first statement is true in the main, and that, without any doubt at all, the conclusion is a wise one, and ought to be followed in practice. To explain this matter will take considerably more space, and in order to understand it we must go to vegetable physiology and enquire into the nature of the evaporation of water from plants. It was long supposed to be a physiological process, and was considered to be entirely different from ordinary physical evaporation. As long as this view was held the process was called transpiration, to distinguish it from the physical process. The breathing pores, the stomata, which occur in the epidermis of all leaves in great numbers, were supposed to be organs of transpiration, which was considered to be one of the most important functions of the leaf.

Within a few years, however, our knowledge of these matters has been greatly increased, and we now know that the escape of water from the leaf does not differ in any way from the evaporation of water from any other moist surface. A leaf is a mass of cells, every one of which is gorged with watery matter, which in a dry atmosphere, as a matter of course, tends to escape. The epidermis, composed of dryish impervious cells, which entirely surrounds the watery cells of the leaf, would prevent almost completely the evaporation of water from the latter were it not for the breathing pores before mentioned. These pores are for permitting the free ingress and egress of gases, particularly oxygen, carbonic acid, and probably, also ammonia. Now, when the pores are open for their legitimate purpose, it happens that more or less water escapes if the air is dry. If the air happens to be very moist, the loss of water through the breathing pores is very little, or even none at all.*

We may put it in this way: *The leaf loses water simply because it is a watery structure*; its epidermis is designed to prevent this loss, and the breathing pores with their power of opening and closing are for the same purpose. A leaf instead of being an organ of evaporation is actually a structure in which evaporation is quite successfully checked. Careful experiments made under my supervision in the Iowa Agricultural College in 1880 by Miss Ida Twitchell, a graduate student, demonstrated that the evaporation from a moist piece of dead wood was exactly like that from a living leaf. Now, when a dead branch

* This is contradicted by McNab, "Outlines of Botany," page 100, who states, as the result of experiments made by himself, that transpiration in a saturated atmosphere with sunshine, as in a greenhouse, is greater than in dry air.—[ED.]

is long enough to keep continually moist in the interior, it will in dry air constantly lose water by evaporation from its surface. This water so lost is taken from the tree, and must have been supplied directly or indirectly by the living portions. Moreover, it must be remembered that a living branch is well protected against loss of water through evaporation by the epidermis which covers all its surface when young, or the impervious corky bark which is always found on it when older. When a branch dies, these protecting devices soon fall into decay, and the water, so carefully guarded by the living parts of the plant, is wasted by evaporation.—PROF. C. E. BESSEY (in the *New York Tribune.*)—*Journal of Horticulture.*

TUSSER SILK IN CHOTA NAGPUR.—The following extract is from the Appendix to the Administration Report of the Chota Nagpur Division for the year 1882-83 :—

About Rs. 89,000 worth of tusser cocoons, manufactured into silk, were exported from Hazaribagh to Moorshedabad and other places, while from Manbhoom and Singbhoom 2,500 and 10,600 kahans respectively of the cocoons were exported during the past year, against the same quantity exported from Singbhoom and 7,500 kahans exported from Manbhoom in 1881-82. The Deputy Commissioners of Singbhoom and Manbhoom are both of opinion that the yield of cocoons in the past year in both districts was very large, though the Singbhoom ryots, to whom I spoke on the subject, complained of the small crop they had got; while the Deputy Commissioner of Singbhoom says that the low rate at which they were sold in the market prevented a large quantity from being exported.

I have for several years past been engaged in making enquiries about the tusser industry, which might possibly, under efficient and intelligent management, become a source of great wealth to the Division.

Tusser cocoons at present are grown either in the jungle tracts of Singbhoom and the Tributary States, or in Manbhoom and the villages in the east of the Lohardugga and Hazaribagh districts. In the jungle tracts they are grown chiefly in the jungle surrounding villages in which there is little cleared land, and the yield from these villages is yearly decreasing, as the extension of clearances moves the jungles further from the village site. More than once I have asked the people why they had given up growing tusser in these villages. They have said, "Why, sahib, when we grew tusser the jungle was close to our houses, but now look how far off it is." As native superstition requires the tusser grower and all his family to submit to a number of ascetic observances, without which a good crop cannot be expected, the people naturally give up growing a crop which entails so much trouble and long journey to the jungles, when they can get very

nearly, if not quite, as large profits from crops grown close to their doors without half the labour and annoyance required by the rules of tusser cultivation.

In the more cultivated villages of Singbhoom, Lohardugga, Manbhoom, and East Hazaribagh the tusser worms are fed on pollarded asun* trees, some of which have been planted for the purpose, but the greater number are remnants of the jungle which once surrounded the village. The usual number of trees tended by each man is from 10 to 20. The average yield, as far as I could ascertain from enquiries made from a number of tusser-cultivators in Singbhoom, is about 30 cocoons per tree, though in a good year a tree ought to yield about 100 cocoons, so that the average number of cocoons yielded by an average of 15 trees is about 450 ; and if the price paid be 8 annas per 80 cocoons, all that he and his family get for their watch of about a month, continued day and night, is a little more than Rs. 5-8. If this were all that could be looked for, the number of people who would go through the drudgery of watching, and the minute observances as to cleanliness and food necessary, would be very small. It is only the chance of a bumper crop of 100 cocoons or more per tree that induces cultivators to try their luck in the trade. The number who cultivate tusser is yearly decreasing, and will decline very considerably in a series of years if heavy rain and wind should make the yield as bad as it was last year in Eastern Lohardugga.

On the other hand, a largely increasing demand for tusser is springing up in England, and during my stay there last year I visited Maclesfield, and spent some days with Mr. Brocklehurst, who owns the largest silk mills in that city, and discussed the subject with him and Mr. Wardle, who superintended the preparation of the dyed silks sent by the India Office to the Paris Exhibition, is the head of a large dyeing firm at Leeds, and has been for years engaged in making experiments in dyeing tusser.

From what I learnt from them, and from some correspondence I have had with Mr. Wardle, it appears that the English silk firms are prepared to take any quantity of tusser waste at from 1*s.* to 1*s.* 6*d.* a pound, but that higher prices for unreeled silk would not now pay in England, while at anything like present rates for cocoons here this price would be utterly unremunerative. Now they can get large supplies from China at these rates, but they have no information whether these supplies will keep pace with the increasing demands of the trade, or whether the China worm, which feeds on the oak-tree, is domesticated or feeds in the jungles. In the latter case the supply is not likely to be largely increased, and a rise in prices, if the demand still continues, may, if the work of production could be reduced, make the export even of Indian tusser waste pay.

* *Terminalia tomentosa.*

The China tusser silk is naturally white, and does not require bleaching, whereas it is a very difficult matter to bleach the Indian tusser. The latter is therefore much more expensive than the Chinese for all white silks, and can only compete with it at present prices in dyed goods and those of its natural colour; but Mr. Wardle writes to me on the 10th March this year—"I should be much delighted if Indian tusser could replace Chinese; I find it is preferred by the spinners." But except when used as waste, he says—"It must be reeled where labour is cheap," as it will not pay for reeling in England.

The price of reeled China tusser given by him in the letter above quoted is from 5*s.* to 5*s.* 6*d.* per pound; but to make a pound of silk according to Major Cousmaker's experiments requires an average of 436 cocoons; and though the cocoons of Chota Nagpur are larger than those of Bombay, where Major Cousmaker's experiments were made, yet as far as I learn from enquiries among the natives, his estimate must be considered to represent very fairly the outturn from cocoons in this country. At the rate of 8 annas for eighty cocoons, the cost of obtaining a pound of silk would be more than Rs. 2-8, or about the price of the best reeled China silk at home without the cost of reeling. Therefore, before even reeled tusser can pay exporters well, the price at home must be increased, or the cost of production must be materially reduced. Feeding tusser worms on asun trees will never pay, as the trees cover a large space, and the yield of the number of trees which one or one family can look after is very small; but if ryots could be induced to plant hedges of *Lagerstrœmia indica* (a shrub on which Major Cousmaker successfully reared cocoons in Bombay) in the gardens close to their houses as they now plant opium and vegetables, the yield of cocoons could be very largely increased. On an acre of wide-spreading asun trees only about 440 trees, yielding an average crop of about 13,000 cocoons, could be grown; whereas Major Cousmaker has reared an average of 20,205 cocoons to the acre on *Lagerstrœmia*, and probably more could be reared on hedges close to a ryot's house and constantly looked after by himself and his family. But of course the ryots will not do this without the hopes of a large profit, and they must therefore be able to get from the small patches of *Lagerstrœmia* they can plant in their gardens more than they now get from the few asun trees they can look after. If a man now gets an average of only about Rs. 5-8, and the industry is declining, it will require at least an average receipt of Rs. 8 to make the cultivation fairly popular; while, if it could be increased to Rs. 10, the number of tusser cultivators would be very largely increased, but only if a family can look after about an acre of hedge planted about two feet apart, and it is only by experiment that an area a family can look after can be ascertained. In order to make a profit on reeled silk at present prices, it would, considering the expenses

of setting up and maintaining filatures with reeling machines, added to those of supervision and transport, be necessary to be able to buy the cocoons at not more that 2*s.* or Re. 1 for the quantity required to make a pound of silk. This would be about in round numbers 440 cocoons, or 110 for 4 annas—a price much less than that now given; but if, on the other hand, the average yield could be raised to 20,000 cocoons an acre by substituting *Lagerstrœmia* hedges for asun trees, a ryot could on one-fifth of an acre procure cocoons which he would sell for nearly Rs. 10 at the filature.

Here, however, another question would arise—Could a ryot and his family look after more than one-fifth of an acre? and if they could not, I very much doubt whether the prospect of getting only Rs. 10 would be held by the more enterprising ryots, such as Kooiries and Koormis, who would alone undertake the cultivation of a *Lagerstrœmia* plot, to be sufficient to compensate them for their trouble, especially as the cocoons must be brought to the filature before this price could be got. I am afraid this would detract greatly from the attractions which the receipt of Rs. 50 for the crop grown on an acre would present if tusser only required the care requisite for ordinary crops. Therefore, even supposing that a pioneer of the trade did appear possessed of the very sure qualities necessary to overcome prejudices of the ryots, the capital necessary to make a profit after many failures and a patience not easily discouraged, the success of his endeavours would be doubtful; but if he did succeed, I believe that owing to the increasing demand for tusser he would make a large fortune, provided the facilities for increasing production in China are not greater than those in India; and as one successful experimentalist would find his example followed by many others, the wealth of the country would be enormously increased by a large and prosperous trade, which would, owing to the cheapness and abundance of labour which the country will probably always furnish, and the probable absence of competition from other countries if Chinese tusser is once beaten out of the market, be likely to be permanent.

FORESTRY AT HOME AND ABROAD.—Vast as the available mineral wealth of the world undoubtedly is, in utilising such items of it as coal and iron, there is the disquieting feeling that every year's consumption is a slice irretrievably gone from the whole. With timber the case is different, for if the advice of the old laird of Dumbiedykes to his son, "to be aye sticking in a tree, for it will grow while you are sleeping," be adequately followed, a perennial supply of wood is assured. If this planting of trees has been too much neglected in the past, it is so far due to the fact that for a long period re-afforesting was not only unnecessary but mischievous. The forests got, by ever so many ages,

the start of man in the struggle for possession of the earth's surface, and since the advent of man he has had toilsomely to win back the soil from the primeval forest. Trees, however, play an important part in the general economy of the globe, and the preservation of an adequate amount of forest is as essential to human interests as is the removal of the remainder. Timber is everywhere a prime necessity for constructive purposes, and in most parts of the world it is the only fuel. Equally important is its climatic influence. Although not increasing the rainfall, forests husband the rain after it has fallen, and so prevent its too rapid flow from the soil. They thus help to regulate the flow of rivers and to prevent disastrous floods, while by checking evaporation they modify the temperature. They further protect the soil from denudation, especially on mountain sides, which, exposed to rain and torrents, soon gets washed away. It has only been by sad experience that those climatic effects of disforesting have been discovered. Turkey, Italy, France, and Spain have all suffered severely from the denudation due to the destruction of the forests which once clad their mountain slopes, and historians have attributed the decadence of Spain largely to this cause. The barrenness of the once fertile Palestine, of Syria, and of Cyprus has been brought about in the same way, while the famines of India and China can be much more certainly traced to the disappearance of their mountain forests than to the coming or going of sunspots. While many countries have thus reduced their area of forest below what is absolutely required for the maintenance of the best physical conditions, as large a number find the home supply of timber inadequate for their economic wants. Great Britain thus imports most of its timber, and the same is true, though to a much less extent, of the principal European nations. The chief sources of timber supply are Scandinavia, Russia, and North America. The last is still comparatively rich in primeval forest, but forest fires, the browsing of cattle and consequent destruction of seedlings, and the growing demand for timber by the Americans themselves for industrial purposes, are bringing the time within measurable distance when the New World will have need for all its forests. If proof of this were required, it is to be found in the fact that at the present time the forest acreage of the United States is less than a fourth of the total surface—a smaller proportion than is found in Russia, Sweden, and Austria, and about the same as that in thickly-peopled Prussia. It was also noted in these columns a few days ago with regard to Canada that the consumption of coal had doubled in eight years, owing partly to the great and increasing scarcity of wood in the settled districts. The timber exporting countries of Europe are believed to have already reached the limit of their capacity in this respect. With an ever-increasing demand for timber, therefore, the prospect that the supply will keep pace with it is not

reassuring. Certain it is that in the future more attention will have to be paid to the formation and management of woods, and to the utilisation for this purpose of waste lands, if the future progress of civilisation is not to be impeded by the scarcity of timber.

With its moist climate, its abundance of coal, and its great facilities for importing timber, Britain does not greatly feel the inconvenience of depending on other countries for its wood supplies, and consequently it has given little attention to the growing of timber. Less fortunate in these respects, Continental nations have been led by the force of circumstances to study *the science and practise the art of forestry with a devotion* altogether unknown in this country. In Germany and France, for example, a forest is regarded as so much capital, represented by so many cubic feet of wood, while "the amount of wood"—to quote from a recent paper by Colonel Pearson—"produced each year by its growth represents the interest thereon, and, in fact, is the revenue of the forest." A quantity of timber equal to the annual increase of wood can, therefore, be cut down without diminishing the original volume of wood. That the greatest possible revenue may be obtained, Continental foresters see that the productive powers of the soil are utilised to the utmost, also that the annual revenue of wood is taken from the ground in the way that shall least interfere with the continuous growth of the forest. In this latter matter the English differs from the Continental practice. In this country it is the usual custom to cut down the mature crop and to plant again; on the Continent the annual revenue of timber is obtained by cutting down a tree here and another there, the gaps thus caused in the forest being left to be filled up by seedlings naturally sown. The thoroughness which characterises the management of the timber crop in such countries as Germany is seen in the accurate maps that are prepared of the various forest districts, with accompanying descriptions of the kind of timber and of the age of the trees in each. There is thus not a tree in any of the woods, big or small, that is not recorded, and that has not its future marked out for it in the working plan of the forest of which it belongs. The intelligence displayed in the management of Continental forests is due to the excellent training received by those in charge of them in the Schools of Forestry. These were founded in Germany so early as the year 1717, and now they are to be found in every important European country except Britain. Austria, according to a recent return, possesses nine of these schools, each with its director and a staff of professors numbering from two to twelve. The small Kingdom of Saxony has its forestry academy, with ten professors and assistants. Prussia has three such institutions, with a total professoriate of 29; while there are no fewer than six classes of forestry in the University of Munich. France has fewer

forestry schools, but in the great institution at Nancy, founded in 1824, she possesses probably the best specimen of its kind in the world. Russia has four such schools, while Italy, Denmark, Sweden, Switzerland, and even Spain, have each at least one establishment for the training of foresters. The course of instruction is, as a rule, extensive and thorough, for, besides forest-culture, it usually includes such subjects as botany, zoology, entomology, mineralogy, geology, and chemistry, besides geodesy and draughting. Candidates for admission to those forest academies are selected with great care, only those who have attained a high standard of education, and who are able to maintain themselves throughout their course of study, being admitted. The result, according to a recent account of German forestry, is that "a thorough forester in Prussia is an adept in natural history relative to forests and their inhabitants, at the same time a geologist, botanist, and chemist, and the possessor of a good general knowledge of the laws of his country. He knows every foot of land in his district; at the various stations he notes the rainfall, the force and direction of the prevailing winds, their humidity and dryness, the temperature, &c."

The neglect of forestry in Britain, as shown in the total absence of schools of forestry, is all the more remarkable from the fact that a demand exists for the education such schools can alone supply. A knowledge of forestry is required by candidates for the Indian Forest Service, and to obtain it men are sent from this country to study at the French academy in Nancy. It is a fact that the British Empire presents the most extensive forests of any country in the world, these having an area of 340,000,000 acres, and already the need of proper forest management is being felt throughout our vast foreign and colonial possessions. The conservation of the forests of India, and the re-afforesting of tracts that have suffered from the injudicious removal of timber, now forms one of the most important departments of Indian administration. The Government of the Cape has lately become alive to the necessity of preserving its forests, and, for lack of a properly-qualified English forester, they have had to give the appointment of Forest Commissioner, with a salary of £800 per annum, to a Frenchman, who does not even know our language. The forests of Cyprus have also recently been put under charge of a French forester. With India and the Colonies to supply, a British School of Forestry ought to be one of the most flourishing educational institutions in the country. The demand for foresters at home is certainly not great. Scarcely 4 per cent. of the acreage of Great Britain is covered with wood, and not $1\frac{3}{4}$ per cent. of Ireland, as compared with 16 per cent. in France, 23 in Prussia, 31 in Austria, and $42\frac{1}{2}$ in Russia. This, however, is no reason why the little we have—and 2,500,000 is not so contemptible an acreage of forest, after all—should not be laid out and managed to the best

advantage. With the exception of 125,000 acres of Crown forests—Windsor Park, New Forest, and the Forest of Dean—which are under careful management, all our woods and plantations, are in the hands of private owners. That judicious, and consequently profitable management of these has been the exception is not surprising, since the owners, without instruction themselves in the science and art of forestry, have not been able to obtain the services of properly trained foresters. The question also arises whether our acreage of wood could not be considerably and profitably increased. It would be obviously foolish to plant timber on land that might be put to better use, but there are, as was pointed out by Sir J. Lubbock lately in the House of Commons, in Scotland and Wales alone from 5 to 6 millions of acres of land at present almost valueless, and much of which, especially on the sides of hills and slopes, might, in the opinion of competent authorities, be advantageously planted with trees. Ireland is one of the least wooded countries of Europe; it has, however, extensive waste lands, which from their situation and character would never repay the cost of reclamation for purposes of tillage. These might by re-afforesting be brought to yield a large revenue, to the great benefit of the sister isle. What may be done in this way, at a comparatively small cost, was lately shown by Viscount Powerscourt in a letter to the *Times*, in which he gave particulars of the planting of 1000 acres of wood on a hitherto waste part of his estates in county Wicklow. The profitable working of the present woodlands would, however, prove the strongest inducement to proprietors to plant timber on their waste lands, and nothing would more hasten such a consummation than the establishment in this country of a thoroughly equipped school of forestry, from which men competent to form and manage forests could be obtained. Apathy, born of ignorance, is, it must be confessed, the attitude of the British public on the question of forestry education. Probably no better method of enlightening the country as to the aims and methods of scientific sylviculture could have been hit upon than that of holding a great International Forestry Exhibition.—*Weekly Scotsman.*

BELIZE.—An interesting article concerning the topography, climate, and industries of Spanish Honduras, written by one of a party of Americans during a short trip into the interior, was recently given in the New Orleans *Lumberman*. We make the few following extracts concerning the Mahogany industry of the country :—Belize is the largest port on this side of Central America, says the writer, and the largest export port for mahogany. The exports of mahogany last year equalled 5,000,000 superficial feet, and it is estimated that during the current year the amount will reach 7,000,000 feet. One-half of this is

handled by the Belize Estate Company. The weight of the mahogany is estimated at 5,000 pounds to the 1,000 superficial feet, and about 10 per cent. less when seasoned. The freight to England is ten dols. per ton. We visited one church which has an altar made of seventy different kinds of native woods, all of which were very beautiful and susceptible of a fine finish. We afterwards visited a native cabinet shop which was of the most primitive style imaginable. Whip saws were used for sawing timber. A Mr. Kindred, long engaged in trade, informed us that his firm hauled their wood from 6 to 10 miles on carts, also ran some wood a long distance through ditches and canals. One log, recently handled, had to be hewn down from 7 feet in diameter in order to float it in their canal to market, wasting fully three-sevenths of the log.

The streets of Belize are narrow and irregular, but are kept very clean. The police are blackmen. The bush is very dense and hunters are sent out who mark the trees, and put a corresponding mark on a stick they carry, getting paid 50 cents a tree for every one they find. Wages average from 10 dols. to 12 dols. a month and "found." The wood is all shipped to English markets, bringing now from 120 dols. to 300 dols. per 1,000 feet. Dishonest measurements and low prices prevent them from shipping the wood to United States markets.

When we reached Livingston we went ashore with a Mr. Ford, mahogany cutter, who handles about 500,000 feet annually. He gets his timber out entirely by manual labour; hauling it on skids by the natives from one-fourth to half a mile, floating it to the port.

We arranged to take a trip up the Ulua River to Santiago. We went about 50 miles the first day through an almost unbroken wilderness of tropic foliage and scenery. The soil is a rich, dark loam, and looks capable of producing to an unlimited extent. Followed a mahogany road about a mile into the woods. Found the road good and the land very rich, and mainly level, covered mostly with a growth of small corosa palm, and very easily cultivated, and ought to be cleared at a cost not exceeding 5 dols. per acre. The Ulua passes through the great plain of Lula, which is about 70 miles long and 30 miles wide, and has been formed by the washings of ages from the mountains that surround it, making one of the richest and most productive soils on the earth's surface; everything being planted by simply cutting down and burning the bush, then making a hole with a sharp stick and dropping the seed into it.

About 65 miles up the river we came to the village of Urraco, situated on a high bluff. The entire village turned out to greet us, some naked, and the balance but thinly clad. A mahogany bank is located here, and we saw several fine logs squared ready to ship. A novel sight seen here was eight men running a cross-cut saw cutting the end of a log, and the ninth

man standing on the log bossing the other eight. Two men had hold of the handles, one at each, and the other six, three on each side, were pulling ropes attached to the handles of the saw.

We passed several mahogany banks and rafts during the day and at dark tied up at Plya Padre, near the mahogany bank of Mr. Bain. His foreman informed us that in 1882 they cut 500 logs, 200,000 feet, and expects to cut 600 logs this year, equal to 250,000 feet, at a cost of 12,000 dols. He employs forty men in the winter and twenty in the summer.

While the boat was taking on mahogany blocks for fuel, we took a stroll of about 2 miles into the woods over a well-constructed logging road. Saw stumps of several mahogany and cedar trees that had been cut, and found that the oft-repeated statement that from 10 to 15 feet of the choicest timber was left in the stump and entirely wasted is false, and that, on the contrary, the trees were cut within from 3 to 6 feet of the ground on an average, and only when an occasional tree would grow with long and narrow roots (similar to cypress knees) above ground were the stumps of greater height, and in such cases but little valuable timber was left standing.

We all rode over to see Lake Yojoa; by riding to the top of a high peak we got a full view of the lake, which is about 20 miles long and 10 miles wide, and, with the exception of a small valley at each end, is surrounded by mountains 1,200 to 1,500 feet high. The lake is surrounded by dense woods on all sides, excepting about 10 miles of the shore on the north-east end. Saw several mahogany trees on the shore, and measured one that was about 7 feet in diameter.

We took an early start next morning, to explore the lake in canoes; six of us got into one and rowed along the shore to the extreme south-west, stopping several times to examine the mahogany and cedar trees, which grew plentifully along the banks and far up on the mountain side. At one place we found an Indian making a canoe out of a mahogany tree which would have made 3,000 feet of choice lumber.

Two others and myself, on mule-back, ascended the Cumbra Peak, about 1,500 feet above San Pedro, and obtained an excellent view of the great Sula Plain, which stretches out as far as the eye can reach, with the Ulua and Chamelicon Rivers, from 5 to 18 miles apart, making a serpentine course through it to the sea.

After describing the various other features of the country, the writer concludes as follows:—To sum up, we have travelled 150 miles up the Ulua River through a plain of boundless wealth in soil and forests. The valuable woods have been cut but a few miles back from its banks, while they extend 10 to 20 miles to the well-timbered foot hills and mountains. The same plain extends to Yojoa, gradually increasing in altitude to

a height of 1,000 feet; while another but smaller plain extends from the north-east shore of Lake Yojoa, to the Blanco River, with occasional interruptions, equally as productive; and yet another on the south-west end of the lake, gradually rising till it reaches Santa Barbara. The same plain of Sula extends from 2 to 18 miles west of the Chamelicon; so that within a distance of 100 miles of the sea a great variety of climate and soil is found, with as healthy a climate as can be found anywhere. We have travelled over a large portion of the country by canoe, mule, and railroad, through the low lands, over mountains, and in the bush, and have used every means of obtaining information concerning the timber and agricultural resources of the country, and are thoroughly convinced that with sufficient capital, well directed, either or both can be carried on at an immense profit.—*Timber Trades Journal.*

We learn that French ingenuity has hit upon a plan to substitute other woods for mahogany, by the following process, and which might be practised on birch, ash, lime, &c., with every prospect of success. The first operation is to plane the surface of any species of close-grained wood until it is perfectly smooth, and then rub it with diluted nitrous acid, to prepare it for the materials to be subsequently applied. These consist of one-and-a-half ounces of dragon's blood, dissolved in a pint of spirits of wine, and one-third of that quantity of carbonate of soda, mixed together and filtered; the liquid in this state is then laid upon the wood with a soft brush, and when dry the application is repeated, with very little alteration, till the wood possesses all the appearance of mahogany.

A Swedish Match Factory.—At Jonkoping, Sweden, is the oldest and largest match factory in the world. It was established 100 years ago, and there are now to be seen specimens of the matches used at the beginning of the present century, consisting of big fagots of wood furnished with a handle and a tip to dip in a bath of sulphur. The wood from which the present kind of matches is made is taken from the adjacent forests, which are divided into fifty sections. Every year one section is cut and then replanted with young trees. The trees are hewed into planks in the forest and cut into slivers in the factory. The boxes are made of the outside of the trees. The factories are on the banks of lakes which are connected with one another by wide canals. Millions of matches are turned out each day. Some idea of where they all go to may be obtained from the statement that there are at least 280,000,000 of matches burned each day in the United States, or an average of five matches for each person.—*Timber Trades Journal.*

That Log!—The great French walnut log brought across the waters by L. Hirsch and Brother, New York City, says the *Chicago Lumberman*, was recently cut in two, and half of it made into veneers. A twelve foot cross-cut saw was especially made to cut it, but in a half day it was broken, and a larger one made. Two days of constant sawing were required to complete the job. Then the log had to be quartered, because the largest veneer knife was not equal to the emergency. The veneers made from the log are described as having a handsome black and orange colour, and beautifully figured. The quarter that was cut contained about 12,000 feet of veneers, which is a basis for estimating the contents of the whole log at 96,000 feet.—*Timber Trades Journal.*

The Forest Act in Bombay.—The ryots in the Colaba collectorate, to the number it is represented of about twenty-six thousand, have lately petitioned the authorities for an alteration of the Indian Forest Act of 1878. The ryotwari complain with a good deal of bitterness of the rules framed by the Bombay Government under the Act, by which it appears they are debarred from utilising the forest produce—loppings, dried leaves, and fuel—for what is called *rab*, or the burning of their fields preparatory to their cultivation; and they ask to be reinstated in their immemorial privileges in respect of the forest and jungle generally. Taxation, already oppressive enough, is, they point out in their petition, onerously increased by the present rules, and a tax of one rupee per cartload of thorny bushes for making fences and for purposes of *rab* is urged as a specific hardship of magnitude.—*Pioneer.*

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NOTE ON THE GROWTH OF SOME INTRODUCED TREES AT THE CAPE.

Most people have heard how European fruit trees and vegetables have thriven when introduced into Australia, especially in the south-east temperate corner, which embraces Victoria and the greater part of New South Wales. A continental flora, rich in strong species and in a variety of species suited to every shade of environment, would naturally make terrible inroads into a restricted island flora. The little temperate region of Australia is cut off from the vast temperate region encircling the northern hemisphere by the semi-tropical region of central and northern Australia and the equatorial seas and islands further north. Africa presents the spectacle of the world's great tropical continent with a climatically temperate fringe of highlands clinging to its southern extremity. The temperate zone of Africa is still smaller than that of Australia.

In this temperate fringe of Africa there are now only small forest tracts, comprising altogether something under 200 square miles in area. There has been a considerable destruction of forests since the advent of the white man to South Africa (about 200 years ago); and there are fossil indications of pre-historic forests; but it is unlikely that the temperate forest region of South Africa was ever comparable, in point of size, to that of Australia. While, therefore, the temperate forest region of Australia has evolved the noble genus of Eucalypts, the smaller forest region of South Africa has evolved no trees sufficiently remarkable to be heard of outside their own habitat. Sneeze-wood (*Pteroxylon utile*) is a timber, which in point of durability, ranks with teak, yarrah and greenheart; and if there were only enough of stink-wood (*Oreodaphne bullata*)* it would keep most imported timber out of the market. But stink-wood

* It is remarkable that in the widely separated forest floras of Cape Colony and Madeira the most valuable forest tree in both countries is a species of *Oreodaphne*.

is scarce and sneeze-wood small; and yellow-wood the most abundant and best growing tree, has a poor reputation as timber. The temperate forest flora of Africa in fact is a small weak island flora, and when we consider how the strong continental floras of the northern hemisphere are making good their footing in the strong island flora of Australia, we may now conclude, that in South Africa there is every hope of very materially improving the forest resources of the country by a judicious introduction of exotic timbers.

In Cape Colony a limited but successful attempt has been made to plant exotic trees on a large scale. That exotics have not been largely planted is scarcely to be wondered at, when it is considered that it is only quite recently that attention has been turned to preserving the fine natural forests of the country. As in other colonies, there are botanical gardens in large towns, very useful disseminators of seeds and plants and young trees. But the young trees sold are usually fruit trees. The pine and oak plantations near Cape Town are the only example of the planting of exotic timber trees on any large scale. I have used the word "plantations," but "woods" is the proper term to employ. The Cape Town pine woods are composed of two pines, *Pinus Pinaster* (the *pin maritime* of the French), and *Pinus pinea* (the stone pine of Italy). These pine woods are one of the most remarkable features in the charming strip of fertile country stretching along the south-east or temperate side of the Table Mountain range. Like true pines they reproduce themselves with the greatest facility. In favourable positions the young pines come up like grass under the old trees. Even on the northern, or dry warm, side of Table Mountain, plantation owners are in the habit of clean-cutting the pine plantations, and leaving reproduction to take care of itself. When it fails, as it must sometimes with this treatment, artificial sowings yield an abundant crop of seedlings. Unfortunately fire sometimes destroys large areas of these pine plantations. Outside the wooded gorges of Table Mountain, the only indigenous tree is *Leucodendron argenteum*, commonly called the silver-tree, from the white silvery tomentum, which covers the leaves like the nap of a silk hat. The habitat of this peculiar tree is confined to the more cool temperate climate of the Cape peninsula. At pretty sylvan Wynberg, and elsewhere on the slopes of Table Mountain, there are natural woods of the silver-tree—sparse open woods with foliage glittering white in the mild clear light of this latitude. Into these unique woods have crept the dark European pines, and the mingled tints are picturesque, offering food for reflection. How far will the strong obtrusive but useful northern species eventually oust the pretty useless southerner? Black and white exist here side by side, as elsewhere in Cape Colony, and, just at present, there is room for both. *Pinus Pinaster* and *Pinus pinea* are the only two pines which

have become naturalized in Cape Colony. The Scotch fir, mentioned in books of travels as growing abundantly at Cape Town, is *Pinus pinea*, Scotch fir or pine being the colonial name for that species. Mr. Lister, the Forest Officer of the Cape division, who has had a long experience with *Pinus pinea* and *Pinus Pinaster*, estimates the rate of growth of the second at about half that of the blue-gum, and of the first about half that of the second. The blue-gum at the Cape does not appear to grow quite so fast as on the Nilgiris. Probably the acre-increment of a close plantation of *Pinus Pinaster* is about five tons (dry wood), and of *Pinus pinea* not more than two or three tons. The edible seed of *Pinus pinea* is not utilized in Cape Colony : its timber is superior to that of the faster growing *Pinus Pinaster*. Both pines show distinct annual rings, quite as distinct apparently as the rings in pine wood grown in Europe. European pitch-pine and deal are very largely imported : in fact, Norway deal is as common in Cape Colony as it is in England. The tropical white-ant is unknown in Cape Colony, so that a tough light wood such as deal is the most generally useful that could be grown. Some stumps of *Pinus pinea* on the northern slopes of Table Mountain gave an average of from five to eight rings per inch of radius : this was with trees 25 years old. In the more recently settled eastern portions of Cape Colony there are naturally not the large pine plantations which are so pleasing a feature in the Cape peninsula. But as far as can be judged from planting on a small scale, *Pinus Pinaster* seems to succeed as well in the east of the Colony as in the different climate of the west (I shall conclude this notice with some remarks on the climate of Cape Colony). Some interesting planting, mostly of *Pinus Pinaster*, has been done on the bleak hills which surround the eastern town of Grahamstown. Not only does *Pinus Pinaster* show a good growth there, wherever planted, but in one spot I observed some remarkable natural reproduction. In a gully was a cluster of planted *Pinaster* pines, showing as fine a growth as is usually met with near Cape Town. I measured one tree 6 feet in girth and 90 feet high, and not an old tree. For it is not much above half a century since the English came and planted their trees and houses on the bare hills now occupied by the smiling little town of Grahamstown. From these trees in the gully young trees, self sown, have spread up the grassy hill side. This was at an elevation of about 1,800 feet, and 40 or 50 miles from the southern coast. It shows that *Pinus Pinaster* can be used here for forest purposes, not only on the seaboard (as in France), but at moderate elevations inland. The Cape Forest Department has now some *Pinus Pinasters* planted still further inland, and at an elevation of 4,000 feet. I do not think the climate will be too severe even at this elevation : frosts there are only such as occur during night, and snow never lies for more than two or three days : the

climate is damper than at some parts of the coast, and I anticipate that both *Pinus Pinaster* and *Pinus pinea*, especially the latter, will succeed there, even better than on the coast.

Pinus pinea is a rather striking feature in Italian scenery from Brindisi upwards. Too often the Italian mountains, bared of forest and cut to pieces by torrents, yield now nothing but the scantiest grazing, and on the rare occasions when the peasant enjoys a fire he draws this luxury from the loppings of the *Pinus pinea* trees in his fields. *Pinus pinea* is naturally one of the most flat topped of pines when old. In Italy this peculiarity is exaggerated by lopping, giving those umbrella-like trees which are sometimes as characteristic of Italian pictures as are palms in paintings of tropical scenery.

The pine trees near Cape Town, with their symmetrical trunks, their lofty dense covert, and their abundant natural reproduction, recall the fir forests on the sandy plains of Alsace. They are certainly equal to the spruce and silver fir, which I had an opportunity of seeing recently in the Vosges.

Almost as successful an introduction as these two pines is the oak (*Quercus pedunculata*). The Dutch brought the tree with them from Holland 200 years ago, and it was the early Dutch settlers in the south-west who planted those groves which are now such beautiful sights in many of the old western towns of the Colony. Various writers, from Anthony Trollope upwards, describing these picturesque Dutch villages, expatiate on the beauties of the old oak avenues—the cool substantially built houses, lying embosomed in oak foliage, and backed by stretches of rich vineyard. This picture is a contrast to the oven-like modern tenement, crowned with its hideous iron roof! In the young English towns of the eastern part of the Colony, the oak has been planted sparingly along with other trees, and there as a foliage tree it seems to have out-distanced all others, though of course Eucalypts show a more rapid growth. The striking feature of South African streets is their extraordinary width, the reason assigned for this being the difficulty of manœuvring the huge waggons of the country. As a consequence, the impression left is somewhat that of a dreary waste of dusty macadam with dwarf houses in the distance. What more calculated to relieve this, and the glare of a nine months' summer, than a double row of oak trees! In the Grahamstown botanical gardens there is a fine show oak tree, its too spreading limbs held together by bands of iron against the strong South African wind. There is a fine avenue of old oaks near the botanical gardens and the new Houses of Parliament at Cape Town. The restoration of this avenue was made over to the Forest Department, and the treatment applied is described at length in the last Annual Forest Report of the Colony.

Fresh from India, and after ten years spent in its torrid fire-swept forests, I must confess that few sights have afforded me

greater pleasure than the bursting into leaf of the oaks in Cape Town, at the end of the brief Cape winter. It was pleasant to renew acquaintance with our hoary old friend "*le chêne pédonculé, messieurs*"! In Italy, Switzerland, and France, I had found the oak leafless; in June, in Cape Town, its last leaves were rustling to the ground. Two months afterwards, towards the end of August, the trees were assuming the glory of their spring foliage.

I cannot remember whether the bursting into leaf of the oak in this mild Cape climate is more sudden and vivid than the same phenomenon in Europe. Certainly it was here very beautiful! And it recalled memories of the old Nancy days and of friends now scattered far and wide. Poor Bagneris has gone to that last rest whither many a tall oak had preceded him; and many of us, buried in the wearisome tropics, have almost forgotten the oak and all he told us about it. I have seen the same old oak fighting a losing battle in Southern India.

The oak at Ootacamund, at an elevation of 7,500 feet, makes twice a year faint-hearted attempts to come into leaf after the south-west monsoon and at the end of the cold weather. Elsewhere in Southern India, 4,500 feet is the lowest elevation at which I have noticed the common English oak planted and growing. It is never leafless there, is stunted, and of poor growth, but still bears fertile acorns. In the eastern portion of Cape Colony, where the climate begins on the coast to show semi-tropical features, the oaks do not lose all their foliage regularly, but the yield of acorns is abundant and regular.

The species of oak which has been planted in Cape Colony for 200 years appears to be exclusively *Quercus pedunculata.* Count de Vasselot in his tours has found only this species, though he informed me that he had searched carefully for *Quercus sessiliflora.* Of the two common European oaks, *Quercus sessiliflora* has a rather more southerly habitat than *Quercus pedunculata.*

It is surprising that this oak should have become so completely naturalized in a climate undoubtedly warmer than its European habitat. In the damper, more European-like climate of the Cape Peninsula, the naturalized Cape oak reproduces itself with facility by self-sown seedlings. All over the Colony the oak bears acorns abundantly and more regularly than in Europe (within my remembrance). The common method of planting oak trees in avenues or near houses, is to go into an oak wood, and dig up a sapling 6 or 8 feet high, and with about as much root as would go into a large kettle. That trees should survive such a treatment is one proof of thorough and hardy acclimatization. I believe that the wood of the Cape oak is not inferior to the wood of the European oak, that the oak in Cape Colony grows faster than in Europe, and that the decay to which the oak in Europe is liable sets in earlier here. No

attempt has been made at coppicing or barking the oak or treating it as Foresters treat the oak in Europe. In the eastern mountainous forests of Cape Colony, it is probable that the oak would be thoroughly at home. Acorns are now being sown in glades and burnt areas of forest with the view of testing this. How far this oak may be useful for afforesting purposes, or how far it may spread into the indigenous forest, will be an interesting subject of future observation.

After seeing the fine specimens of the Turkey oak (*Quercus Cerris*) at Kew, the reflection is natural that if *Quercus pedunculata* grows well in Cape Colony, *Quercus Cerris* ought to grow better. And *Quercus Cerris* is a finer tree, yielding better timber than *Quercus pedunculata*. An application has been made to Kew for acorns of *Quercus Cerris*, in order to test its growth in different parts of the Colony. There is an oak, said to be *Quercus Cerris*, and to be about 8 years old now, growing in the Government Gardens at Cape Town. It is stated to have not yet produced good acorns. We should be thankful to any friend (and happy to exchange seeds with him) who would send us some Himalayan acorns, or indeed any Himalayan seeds, notably Deodar.* And here it may be remarked, that the climate of the eastern forest country of Cape Colony, resembles the temperate climates of the Himalayas, in its comparatively dry winters with occasional falls of snow, its rainy summers, its latitude, and its mean temperature. It differs in being subject to droughts at intervals of from 5 to 10 years, and to brief hot winds from the interior, which send the thermometer above 100° for some hours. These hot winds may blow at any time of the year, though they are mitigated in winter. In winter they do not range much above 80° Fah. In summer they reach 110° and occasionally 115°. During the night they are always stopped, especially near the sea, by a cool current from the Southern Ocean, and differ in this respect from the hot winds of Australia, which blow at a temperature of about 120° for two or three days together. The best of the eastern forests of Cape Colony are between elevations of 3,000 and 4,500 feet, which in mean temperature probably corresponds with an elevation of between 6,000 feet and 7,000 feet in the Himalayas.

Amongst the introduced timber trees of Cape Colony, after the European pines and oak, it will be proper to speak of the blue-gum of Australia (*Eucalyptus globulus*). The blue-gum is more widely planted in South Africa than any other tree, but it rarely shows self-sown seedlings, and consequently has not the forestal value of the oak and the pines. I shall not easily forget my introduction to the blue-gum, in its own hemisphere and latitude. It was my first morning on shore near Cape Town. People with their English habits were in bed

* We will endeavour to meet KAD HANDI'S wishes as soon as possible.—[ED.]

or at breakfast, and I had the fresh morning air to myself. There was a lightness and a freshness about this air, wonderfully recalling the Nilgiris, and this illusion was complete when I passed out of the perfumed pine woods to where some giant blue-gums stretched their limbs across the road, and filled the air with their strong wholesome scent. All along the coast of South Africa, from above Cape Town to Natal, the blue-gum grows with facility and rapidity—nearly the same powerful assimilator of carbon that it is on the Nilgiris. Ten tons has been mentioned as the acre-increment in Natal. Approaching the colder western coast this figure probably diminishes, but there are no plantations sufficiently large and regular on the coast to afford any reliable figures of growth. In the drier climate of the interior, the blue-gum succeeds best when there is subsoil moisture. It is extensively planted round farms everywhere, and is said to have modified the mild malarial fever which is prevalent in some portions of the Transvaal, an elevated plateau (about 4,000 feet elevation) which extends northwards into the tropics.

On the same plateau, at the large English town of Kimberley (the diamond fields), where a bad form of malarial fever is prevalent in summer, and where firewood sells at fancy prices,* Eucalypts have been planted just sufficiently to show that they will grow well there. There is now a plentiful supply of water at Kimberley from the Orange river, and altogether the best prospects of successful Eucalypt planting. The only portion of Cape Colony where the blue-gum appears not to succeed is on the last range of high mountains rising to the plateaux of the interior. On these mountains, especially if the aspect is southerly, the snows and frosts of winter are too severe for the blue-gum. In the semi-desert country to the North-West, where the rainfall ranges from 10 to 15 inches down to only a few scanty uncertain showers, Eucalypts can naturally not be grown without irrigation. The blue-gum and other Eucalypts have been most extensively planted in the neighbourhood of Cape Town. In certain situations they suffer there from wind, and the wood, as firewood, has a bad reputation for being twisted in the grain and difficult to split. Grown in close plantations these objections would probably disappear.

Speaking generally, the blue-gum appears to grow less rapidly in Cape Colony than on the Nilgiris, and there are other Eucalypts which rival, or even surpass it, in rapidity and robustness of growth. In appearance, the average blue-gum on the southern sea-board of Africa is about equal to those I saw in Italy, both being somewhat inferior to the Nilgiri tree.

* At the present moment, owing partly to a small-pox scare, the price of firewood is mentioned in the papers as being £50 a load at Kimberley. Imagine the value of a few acres of blue-gum with an acre-increment of ten tons and these prices.

With regard to the natural reproduction of the blue-gum, coppice shoots are not so plentiful nor so strong, as I remember them a year ago, on the Nilgiris ; but on the other hand, self-sown seedlings occur in certain situations in Cape Colony, while on the Nilgiris it is a notable fact that they are practically non-existent. Probably both the lessened power of coppicing, and the occurrence to some extent of self-sown seedlings, is due to the fact that the Cape climate is drier* than that of the Nilgiris: the Cape climate is warmer as regards air temperature than the Nilgiris, but as regards the sun quite extra-tropical, being in latitude 34° as against the 11° of the Nilgiris. The mean temperature of Cape Town is 61·25, and the rainfall 24 inches. On the cool side of the Table Mountain range, where the pines, oaks and blue-gums attain such fine dimensions, the rainfall is greater and the temperature slightly less. On the Nilgiris, where the blue-gums grow best, the mean temperature is about 56°, and the rainfall 45 inches. It is remarkable, that the best show of self-sown blue-gums in Cape Colony, is believed to be at a farm some distance from the south-west coast, where the rainfall is less than in Cape Town. Here, in this one locality, the young blue-gums are described as coming up like grass : the situation is dry and open, and the soil somewhat stony. Near Cape Town, self-sown blue-gums are observable, but they are not common. All over Cape Colony the blue-gum produces fertile seed, and no other is used in nurseries ; while on the Nilgiris, it is necessary to use Australian seed on account of the bad quality of indigenous seed.

Of other Eucalypts only one I believe has been at all extensively planted. This was at first believed to be *Eucalyptus Mahagoni*, but was subsequently identified as *Eucalyptus robusta.* In Southern India I found it to succeed at 2,000 feet lower elevation than *Eucalyptus globulus,* and in Cape Colony it appears to stand drought better than *Eucalyptus globulus.* Mr. Lister is very sanguine of its successful and easy planting. I have rarely witnessed a more rapid and vigorous growth than that shown by this tree in the town avenues and in the Government plantation at Worcester. It is now being tried in the east of the Colony. Its compact form, and (for a gum tree) dense foliage, render it fit for avenue planting.

Of other Eucalypts, a great variety has been planted, by twos and threes, in different parts of the Colony. Very many of these I recognize as having been more or less successfully planted in Mysore. The valuable yarrah has been identified

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* We should add "and warmer." The greater dryness has for result the production of a smaller number of buds, while, on the other hand, the higher mean temperature, and the presumably brighter sun force a larger number of these buds to develop into leaf and wood, thus allowing a comparatively small number to remain dormant.—[ED.].

by Mr. Lister, growing near Cape Town, and yielding good seed. The sweetly scented *Eucalyptus citriodora*, which succeeds as a garden tree in Mysore, grows well in Cape Colony, but was found to be sensitive to drought in the Botanic Gardens at Port Elizabeth on the southern coast.

KAD HANDI.

(To be continued).

GUINEA-GRASS AND LUCERNE.

In dealing with the important question of fodder-reserves, it is profitable to notice the great success which has attended the cultivation in this country of guinea-grass (*Panicum jumentorum*) and lucerne (*Medicago sativa*). Lucerne is grown in small quantities in most places where Europeans are to be found, but guinea-grass is not so generally known. It was introduced into India apparently not much earlier than 1870, in which year it was cultivated at the Madras Experimental Farm. Directions for sowing it are contained in the Proceedings of the Agri-horticultural Society for 1871. The Agricultural Department, Punjab, has recently published a short collection of disconnected papers on guinea-grass and lucerne, but there seems to be no other such publication ; and it is probable that if any exists, it is to be found only in official libraries, and consequently inaccessible to the general public. Lucerne is alluded to in the Introduction to Duthie's *Grasses of North-Western India*, but it is not mentioned elsewhere in this book, and finds no place in Duthie and Fuller's *Field and Garden Crops*. Pogson in the *Manual of Agriculture for India* disposes of lucerne in half a page, and guinea-grass he mentions not at all. He gives high praise to buffalo-grass (*Euchlana* or *Reana luxurians*), but if it is to be cultivated as Pogson instructs, it is doubtful if any one will cultivate it at all. It requires too a very rich soil and heavy irrigation, and cannot be grown on a large scale except at great expense.

In the plains of India it is impossible to cultivate clover and the pasture-grasses of Europe. The heat of summer destroys them at the time when fodder is wanted most. Dúb grass is almost everywhere available, but it is a poor food in the hot weather, and does not repay cultivation. If therefore good fodder is required, resort must be had to grasses which will flourish even in the hot season either with or without irrigation. Lucerne and guinea-grass seem to answer these requirements. Lucerne will grow anywhere in the plains, and if irrigated will keep green through the hottest weather. Guinea-grass will grow on fairly good soil without irrigation even in the hot weather, provided that care be taken of it when young. It

dries up at the first approach of frost or cold weather to shoot up again in the spring; while lucerne grows all the year round except in September and October.

Guinea-grass may be cultivated either from seed or by means of cuttings from the roots of old plants. The beginning of the rains is the best time for sowing, but with care guinea-grass may be raised at any season. The seed should be sown thickly in beds well pulverised and manured. If the seedlings are to be transplanted, the seed may be sown broadcast; if no transplanting is to be done, the seed should be sown in drills 2 inches deep and 2 feet apart. Great care must be taken to keep the young plants free from weeds, and for this reason sowing in drills is preferable to broadcast sowing. Seedlings may be transplanted when 4 or 5 inches high. The ground in which they are to be placed should be well broken up and harrowed; and the young plants should be set out in rows 2 or 3 feet apart. If there is no rain the seedlings should be watered daily. When the rains set in they need no further care except to be kept free from weeds. Weeding should be continued till the seedlings are 18 inches high, when they may safely be left to themselves. From seed sown early in the rains green fodder may be cut in August if the growth has been at all successful; and hay may be made towards the end of September when the grass is neither too green nor too dry. Guinea-grass when in full growth requires little care, but it should be manured occasionally in the cold weather, and will be all the better for irrigation in May and June.

If guinea-grass is to be raised from rootlets these should be pulled off from old and strong roots, and planted at short intervals in ground prepared as for seed. The outturn of guinea-grass per acre is very heavy, and may be anything up to 1,000 maunds. The Municipal garden at Coimbatore in 1876 produced an average crop of 960 maunds per acre on a field of five acres. In 1878 at the Cawnpore Experimental Farm the outturn was at the rate of 360 maunds per acre. In 1881 at the Saharanpur Botanical Gardens the yield was 600 maunds per acre. The average outturn of green *juár* or *chari*, which is the principal fodder crop of Northern India, is 300 maunds per acre (*Field and Garden Crops, Vol. I.*) These figures are worth consideration. Independently of the actual yield of guinea-grass, it is far superior to *juár* in hardiness and power of resisting the effects of drought; and it is a perennial, while *juár* is an annual, plant. Furthermore being a perennial grass, its roots grow strong and large, and make their way deep into the soil, where moisture is found which no annual plant could reach.

Lucerne is cultivated with very little difficulty. It should be sown broadcast on ground well broken up and manured. According to Pogson and other authorities the spring is the best time for sowing, and lime the best manure. The outturn of

lucerne varies according to circumstances, and should not be less than that of guinea-grass. In 1883, four bighas under lucerne at Dera Ghazi Khan produced 930 maunds of green fodder in six months (January to June).

J. S. C. D.

GEOLOGICAL MAP OF THE MUNICIPALITY OF MUSSOORIE WITH THE LANDOUR CANTONMENT AND RÁJPUR, N.-W. PROVINCES.

This Map shows the different kinds of rocks which are found within the limits of the Municipality of Mussoorie. Mussoorie hill station occupies a large portion of the Mussoorie hill range, which extends from the River Jumna eastwards, and rises between the elevated valley of Dehra Dún and the valley of the Aglar river which flows into the river Jumna. The range begins with the prominent Badráj mountain (7,318 feet above sea level). Minor peaks are—

Banóg, ...	...	...	...	7,432 feet.
Cloud-end,	...	...	...	7,032 „
Háthipaon,	...	...	...	7,088 „
Abbey Hill,	...	...	...	7,092 „
Blucher's Hill,	...	...	...	7,187 „
Vincent Hill,	...	...	...	7,006 „
Camel's Back,	...	...	...	7,029 „
Castle Hill,	...	...	...	6,909 „
Landour Station,	...	...	...	7,533 „
Masrána, ...	...	...	...	7,699 „

Furthest east beyond the boundary Tóp Tíba 8,569 feet.

Rájpur is situated at the foot of the range, and the lowest point is only about 3,000 feet above the sea. In this low situation we find the youngest rocks, the tertiary sandstones of the Dehra Dún. They are not much exposed owing to the presence of more recent débris and alluvium. Near a ruined house called Constantia, there are large blocks of a white sandstone, which I take for tertiary.

The main range is made up from a succession of sedimentary strata, aggregating to a thickness of about 6,000 feet. In addition there are numerous outcrops of trap. The age of the sedimentary strata is not fixed because fossils are absent. It is, however, very probable that the limestone series is identical with that of the Król near Simla, which is thought to be contemporaneous with the Trias. All the strata of the main ridge may, therefore, be taken as earlier secondary.

The following is a list of the strata, with their estimated thickness arranged in descending order. The tertiaries already mentioned as belonging to the valley of the Dún are placed at the

beginning, and the list concludes with the eruptive trap rocks, which will be referred to hereafter :—

Tertiaries, ...	800 feet.
Jhabarkhet white quartzite, ...	300 "
Landour grey grits and shales,... ...	500 "
Khaki shales, ...	200 "
Chertbanks and carbonaceous shales, ...	100 "
Limestone beds, ...	1,200 "
Yellow shales included in the limestone beds, ...	200 "
Rájpur quartzites, ...	600 "
Blue and variegated shales, ...	600 "
Trap, ...	eruptive.
Total thickness of sedimentary strata, ...	4,000 "

The lowest rock consisting of dark blue shales, is well seen on the ascent of the road from Rájpur to Mussoorie. The toll house is built on this shale, and the dark blue outcrops are seen a good distance along the base of the range. On the road from Rájpur to Sahansra Dhára, a point three miles east of Rájpur, these same shales are seen to continue, and even to form small hills in front of the main range. The dark blue shales are succeeded by purple and green shales, which show particularly well along Mackinnon's Brewery cart-road.

Next in ascending order follow grey shales and whitish quartzites. In the region of the quartzites on Mackinnon's cart-road were found blocks of barite amongst the débris of the hill side. No barite was found *in situ*. After the quartzites and grey shales a few beds of varying composition and color with calcite veins and dolomitic concretions bring us to the great limestone formation. This limestone formation, excluding about 200 feet of enclosed yellow shales, has a thickness of about 1,200 feet. The yellow shales divide the formation into about equal parts. The lower part consists to the greatest extent of dark crumbling more or less porous rock. Much of this is pure dolomite, and one analysis showed, besides much hydrogen sulphide and bituminous matter, 0·1 per cent. of free carbon. This free carbon is left as a soot black powder when the rock is dissolved in acid, and it is sufficient in quantity to account for the dark color of the rock. This rock occurs along the Rájpur-Mussoorie road repeatedly, and must on no account be mistaken with the lower blue shales and with other black shales which will be mentioned hereafter. Some crumbling rock is mixed with pure white calcite so as to produce a speckled appearance. There are also about 20 feet of a pure white, very fine grained marble. This bank occurs near Jharipáni, and a similar specimen from Cloud-end has been analysed (Analysis No. 7).

In close proximity to this bank of pure marble there is near Jharipáni a vein of crystalline white dolomite about 10 feet

thick (Analysis No. 3). At one point there is even a layer of white sand intermixed with the limestone. The yellow shale is well seen near Fair-lawn on the Rájpur-Mussoorie road, and again near Barlowganj, also near Whymper's Brewery. The upper portion of the great limestone deposit contains more generally massive grey or dark blue limestone and grey dolomite. The very last layers consist of a more argillaceous dolomite. Some of the massive magnesian limestone has a peculiar structure and markings of rounded forms and twisted and curled veins. Such rock occurs between Barlowganj and Mussoorie. The massive dolomite forms many of the prominent cliffs and hill tops of Mussoorie. The prevalence of magnesia is shown by the analysis to which I will have to refer hereafter again. Gypsum of white color and distinctly crystalline occurs throughout the lower portion of the limestone formation. I could enumerate almost a dozen places where gypsum was found. The most important outcrops occur, however, in the valley of Sahansra Dhára in the limestone. The snow-white gypsum occurs in layers, which may aggregate to 20 feet thickness near Selkót, north of Sahansra Dhára.

At Sahansra Dhára blocks of gypsum are washed down by a torrent from the southern aclivity. Another mineral is magnesite, which was discovered by Captain F. Pogson in the limestones near the Happy Valley. I give the analysis (No. 4). Its occurrence is a further proof of the prevalence of magnesia. Calcareous incrustation is of course to be expected amongst such vast outcrops of limestone. Beautiful accumulations of calcareous tuffa are seen at Sahansra Dhára, at the Mossy Falls, Bhatta Falls, Kempti Falls, and other waterfalls which are often visited from Mussoorie. At Sahansra Dhára the springs and rivulets of water charged with calcium carbonate yield beautiful incrustations on leaves and woods and other objects. Calcareous tuffa is often used for building purposes, retaining walls, &c.

The tunnel which was made by the Sappers and Miners a few years ago, for the conveyance of fresh water in pipes, is pierced through the upper solid limestone beds on the northern spur of Castle hill, and is 500 feet long.

Above the limestone follow the chertbanks and carbonaceous shales. The chertbanks are black chert in layers of about 2 or 3, sometimes up to 6 inches thickness. Above them comes black highly carbonaceous shale containing much pyrite. At Castle hill between Mussoorie and Landour, in the so-called ash pit, these layers show very prominently with remarkable contortion. I found in the shales there pyrites in a piece 2 feet long and 2 inches thick.

Many other outcrops of these cherts and black shales occur, for instance near the Club and south of Landour bazar, also near Midlands, and on the slope of Pari Tíba, and far to the east near

Masrána. The relative position of the chertbanks can be made out so as to leave no doubt. They overlie the limestone series, and are accompanied by the black carbonaceous shales.

Next the dark cherts and carbonaceous shales come shales and grits and quartzites, which are particularly well known as forming the high ridge upon which the Landour Cantonment is built. I made three separate divisions, which are shown on the map. The lowest, that of the khaki or earth-colored shales, is also well seen on Castle hill. In the grey shales and grits quartz is predominating, but there are also banks and nodules of impure dolomite. Some of the dolomite is dark red, and contains so much iron, silica, &c., that it melts like slag to a black pearl before the blow pipe. (Specimen from near Haycroft on General Parrott's Estate).

The white quartzite is shown on the map with a separate color. It is of considerable thickness, very striking and often as white as marble. This is the uppermost stratum of the range.

Pari Tíba, or Fairy hill, shows a very regular succession of the strata from the limestone to the dark hard shales, which form the top, and which are identical with the Landour grits and dark shales. Midlands, a lower hill between Pari Tíba, Landour and Mussoorie, is crowned by the khaki shales.

Regular as the superposition of these beds is, they are anything but level in position. The limestone forms a great synclinal wave. From the great outcrop between Cloud-end and Castle hill it bends down below the Landour hill, cropping out deep down at Sahansra Dhára on the south, and in the Aglar valley on the north. Then it appears again at the top of the ridge near Masrána and Jalki rising to Tóp Tíba. The lower strata visible near Rájpur come up to the top of the ridge at Badráj mountain, where the quartzites of Rájpur road are evidently repeated, though forced up to so much greater height.

At the southern foot of the range the dark blue shales and the Rájpur quartzites dip northwards, and on mount Badráj north-eastwards.

The limestone beds between Badráj and Landour have generally a north-east dip, but there are great many irregularities and local contortions. The chertbanks and carbonaceous shales are of comparatively small thickness, and the contortions and irregularities of position are, therefore, all the stronger.

Near the Club and round Castle hill they are, in spite of the contortions, generally level, but on the south side of the Landour bazar they slope down with the hill side. At the junction between the limestone and the khaki shales on the Tehri road, west Landour, the chertbanks extend far down the southern hill side standing on edge. Round the western base of Midlands, the chertbanks crop out comparatively level, and the same round a portion of Pari Tíba hill.

The Landour grey grits and shales strike at Landour generally

parallel to the ridge, which extends from north-west to south-east, and their fall is towards the north-east. Then a synclinal is formed, and on the other side of the valley, on the Moru hill and Jhabarkhet, the strata dip towards the south-west. The white quartzites agree in their dip generally with the rocks on which they rest.

The trap rocks crop out in the limestone. One outcrop is on the Rájpur-Mussoorie road at Barlowganj. The road cuts through the trap for a distance of about 200 feet. The rock is much broken up, and it would not be possible to obtain many compact pieces of more than a cubic foot. The rock is of a greenish color and more or less speckled, owing to the different crystallised minerals, which are mostly in a decomposed state. Half a mile east from Barlowganj at the Mossy Falls several more outcrops occur. The largest outcrop is quarter mile north-west from Barlowganj at Whymper's Brewery. There we can go a distance of 1,000 feet along the Brewery road through trap. The next is at Snowdon, and two more near Cloud-end. Minor outcrops may be seen at St. George's School, on Mackinnon's cart-road between Bhatta village and Whymper's Brewery, and at the Park. Outside of the range of this map I found repeatedly outcrops of trap near Chamansari south-east from Pari Tíba on the way from Sahansra Dhára to Landour. The wide-spread occurrence of trap makes itself felt in the presence or fragments at Dehra in the gravel which is brought down by the torrents which rise in the Mussoorie range. This gravel is composed of the débris of all the Mussoorie rocks. The black chertbanks are also well represented by fragments of the black chert. Limestone of all kinds is also there, but the bulk of the gravel is bluish shale.

The strata of the Mussoorie range include no good building stone. The limestones and dolomites are almost the only durable stones, and they are difficult to shape. The calcareous incrustations (tuffa) are sometimes used for building and for retaining walls. The Landour grits and shales yield some durable and well shaped flags.

Other shales are sometimes used for retaining walls, and after a few year's exposure they fall to pieces. The pure white marble which occurs in the limestone is all in fragments, the largest about a cubic foot. It is uncertain whether large compact pieces could be got from greater depths.

The most important mineral product is the common limestone of the range. Mussoorie proper is almost entirely built on limestone. The principal peaks—Abbey hill, Vincent hill, Camel's back, Banóg, and St. George's School, are all limestone. It has already been said that magnesia is very prevalent. The following shows the results of chemical analysis :—

1. Fine grey dolomite from the top of Camel's back.
2. Dark crumbling rock near Jharipáni.

3. White crystallised dolomite near Jharipáni (analysed by Messrs. Copeland and Blanchfield).
4. Magnesite from near the Happy Valley (Captain F. Pogson's discovery).
5. A mixture of 50 specimens from limestone and dolomite all over the Mussoorie range.
6. A mixture of 50 specimens of limestone and dolomite as they are used for lime burning in the torrent beds which flow down to Dehra.
7. Fine grained white marble from Cloud-end (Qualitative analysis).

	1.	2.	3.	4.	5.	6.	7.
Calcium carbonate, ...	58·9	50·4	48·8	13·5	56·7	72·4	100·0
Magnesium carbonate, ...	33·2	47·1	48·2	69·1	83·3	17·1	0·0
Residue of silica, alumina, &c., ...	4·7	0·5	0·3	13·2	6·1	9·6	trace.
Water, bituminous matter and loss,	3·2	2·0	2·7	4·2	3·9	0·9	0·0

These analyses show that there is not only strongly magnesian limestone forming one of the highest peaks, but the dark crumbling lower strata contain perfect dolomite. Further a collection of 50 specimens made promiscuously all over the station and hill range, resulted in a mixture which contained one-third of its weight of magnesium carbonate. This is ample proof that magnesium limestone preponderates in the outcrops. Somewhat purer limestone comes down with the boulders and gravels in the torrents which flow into the valley past Dehra. These limestone boulders and fragments are all picked up and burnt into lime. The analysis of 50 specimens gave 17·1 per cent. of magnesium carbonate. The limestone detritus which is washed into the valley, contains comparatively less magnesia than the average of outcrops at Mussoorie. Perhaps this is owing to greater resistance of the dolomite outcrops to the weather. It is easy to classify the limestones in the torrent beds; a mixture of better pieces which gave effervescence with cold acid contained 87 per cent. of calcium carbonate, a mixture of pieces which gave no effervescence with cold acid contained only 55 per cent. of calcium carbonate.

The latter mixture proved also to contain some proportion of calcium phosphate. The dark crumbling rock No. 2 near Jharipáni left a black residue after its solution in acid. This residue contained free carbon, which amounted to 0·1 per cent. in the sample. A great many specimens of the limestone gave when

broken a strong bituminous smell. That the drainage water takes up large quantities of lime and forms again incrustations has already been remarked. There is a spring at Sahansra Dhára, three miles east of Rájpur, which contains hydrogen sulphide in considerable quantity. The smell of the gas is noticed 20 yards from the spring. Silver coins placed in the spring get blackened, and lead acetate solution colors the water dark brown. Besides this hydrogen sulphide, the spring contains carbon dioxide, calcium carbonate, magnesium sulphate and calcium sulphate. The latter compound appears to be present in the largest quantity.

III. Notes, Queries and Extracts.

The International Forestry Exhibition.—Through the courtesy of Earl Granville the Executive Committee of the Forestry Exhibition have now been made aware of the disposition and intentions of many of the foreign Governments of Europe with regard to this enterprise. These are in all cases most friendly. Some countries, such as Egypt, Tangiers, Greece, &c., *from the small number of their forest products*, and the imperfect knowledge of their amount and uses, or from the short time at their disposal in the absence of a regular forest department, are unable to contribute. Other countries, like Belgium, Portugal, Switzerland, the Netherlands, and Hayti have caused notices of the exhibition to be inserted in their respective official gazettes, and have directed the attention of their people towards it. The Government of the United States, whose former superabundance of wood has been rapidly decreasing under the vast demands of trade, will take every available means to give the subject due publicity and to contribute thereto. The attention of the Governor-General of the Netherlands, India, has been also officially invited. The Maharajah of Johore, whose territory lies adjacent to our Straits Settlements, has joined in the list of patrons, and proposes to send exhibits. The Rajah (Sir C. Brooke) of Sarawak, while unable himself to contribute, has directed his representatives in Borneo, Siam, and Java, to give all assistance to the directors of the Borneo Company in forming a representative collection. Several officials of the Shah of Persia have heartily taken up the idea, and have announced *their intention of exhibiting.* Meanwhile, applications for space as well in the building as outside come in from private individuals in large numbers, and the careful scrutiny of the merits of such applications is increasingly apparent and necessary. An offer of a prize of £50 for an essay on the best method of maintaining the supply of teak as regards size and quality, together with the best substitute for shipbuilding purposes, was made by the shipbuilders of Glasgow, and was accepted.—*Timber Trades Journal.*

How Creosoted Timber burns.—One objection which has been urged against creosoting as a means for preserving timber, in addition to its expensiveness and the difficulty in the way of thorough injection, has been the alleged inflammability of wood

treated by the creosoting process. As the creosote is in the form of dead oil or tar, the burning quality of wood impregnated with it would, inferentially, be excellent. Yet it is claimed that, in a recent case, this theory was substantially demolished by results. An establishment for creosoting piles and planks was burned in New York a few days ago, to which the presence of creosote afforded considerable protection against the fire. The fire is thus described: The building was of pine and spruce in their natural state, except the sills, which were made of creosoted pine. The latter were set on posts and raised about a foot above the ground, so that the flames had a chance to get under them; they were charred, yet retain their form and a certain amount of strength, whereas not a piece of the untreated lumber could be found. Scattered over the premises were numerous creosoted piles, and several thousand feet of plank, all charred, but the pieces mostly retained their original form and a certain degree of usefulness. Where the flames could reach the comparatively uninjected heart wood, they ate into it, leaving a charred creosoted shell. In all the above charred pieces the fire went out of itself: creosoted wood burns with a dense black smoke, which probably has a smothering effect.—*Lumberman.*

TIMBERS AT THE CALCUTTA EXHIBITION.—Having inspected the basket-ware and the trade samples of jute and gunnies, the visitor's attention will in all probability be engaged with the beautiful gateway which forms the northern entrance into the Economic Court. This was constructed by Mr. F. B. Manson, the Forest Officer in charge of the Forest Department exhibits. This magnificent conception is in structure similar to the Indian-corn arch, but instead of corn cobs, it is built up entirely of blocks of differently coloured woods, neatly arranged and polished. I was told that there are over 2,000 different pieces of wood used in the construction of this, the trophy of the Forest Department, and the taste and care bestowed upon it do great credit to the Department and to Mr. Manson, who had entrusted to him the work not only of constructing this trophy, but of receiving all the timber collections, and of classifying and arranging these. I am sure every one will agree with me in thinking Mr. Manson did well to follow out the same plan as was pursued by Dr. Watt in his general arrangement of the Economic Court, namely, to select an index collection, and to use the duplicates for ornamental purposes. On the wall will be found on racks a complete set of blocks of all the Indian timbers, alphabetically arranged, so as to facilitate rapid reference. Mr. Manson has prepared a valuable catalogue of these, which, with the sanction of the author, is an abstract form of Mr. J. S. Gamble's *Manual of Indian Timbers*, arranged alpha-

betically. I have little more to add to the subject of timbers; most are well-known, and I venture to think a much larger and more perfect collection was sent from India to the Paris Exhibition than is now on view at the great Calcutta International Exhibition. This is certainly to be regarded as a very great mistake, and I think it remarkable that there should be two or three much larger and more perfect collections of Indian Timbers in Europe than we possess in India. In fact I believe no fresh collections have been made for the Calcutta Exhibition, and, with the exception of a few blocks from Bombay and Madras, all have been exhibited before. I noticed, however, one new collection of a practical nature, namely, a series of seasoned and corresponding green woods of the leading tea-box timbers tied up with sheets of lead between each. These have been subjected to the most severe ordeal possible, in order to ascertain the action of the wood upon the lead. I had the pleasure of seeing a few of these opened, and although in one or two instances the wood had become almost rotten, the lead had not been in the least corroded. The reports which have agitated the public mind on this subject would therefore seem to be incorrect. The wood has no action upon the lead whatever, and if it is the case that the lead had been found corroded on arrival of the tea chests in Europe, this would seem to be due either to impurities in the lead itself, or to some chemical action of the tea, or of certain preparations of tea only, upon the lead and not to any action of the wood upon the lead, whether used seasoned or green.* Before leaving the Economic Court I must pronounce it a most perfect success, replete with interest to India and India's future.—*Pioneer.*

CURRENT PRICES OF ENGLISH TIMBER.—There is very little alteration in the prices of the various kinds of timber since our last report in September: selected oak and ash command a firmer price, beech is rather scarcer and dearer, in poplar very little has been doing, and frequently holders accept very low prices to clear, for some local reason or some particular circumstance; sycamore of large size and good quality is very scarce, and much inquired after, the price obtainable continues to improve.

The price list represents the average prices obtainable by proprietors for timber lying within a three or four mile haulage to a station, with reasonable rates to the chief consuming centres.

Good selected oak,...	1*s.* 9*d.* to 2*s.* p. c. ft.
Second quality ,, ...	1*s.* to 1*s.* 6*d.* ,,

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* Mr. Young, Forest officer in Cachar, has proved that green *Mangifera sylvatica* wood, corrodes lead after being in contact with it for a fortnight only. —[ED.]

Good selected ash, ...	...	...	1*s*. 6*d*. to 2*s*. p. c. ft.
Second quality „ ...	...	...	1*s*. to 1*s*. 6*d*. „
Elm fair average, ...	...	...	9*d*. to 1*s*. „
Poplar average, ...	...	...	5*d*. to 8*d*. „
Willow „ ...	...	...	6*d*. to 10*d*. „
Larch large fair average,	...	...	1*s*. to 1*s*. 3*d*. „
„ small „	...	...	9*d*. to 1*s*. „
Beech, „	...	...	9*d*. to 11*d*. „
Sycamore large, ...	...	...	1*s*. 6*d*. to 2*s*. 6*d*. „
„ small, ...	...	...	9*d*. to 1*s*. „
Horse chestnut, ...	...	...	6*d*. to 9*d*. „

—*Timber Trades Journal.*

RUBBER.—An esteemed correspondent writes to us:—"The Nagas in this portion of the Naga Hills (above Amgourie tea garden) are getting a good deal of rubber from a woody vine. The vine climbs trees and grows to three or four inches in diameter. When the seed-pods are ripe, they burst open, and a light flimsy material comes forth, and is wafted about by the winds. It is this fact that gives to the vine its Naga name *Apungmange*. The botanical name I do not know. The vine is common in the forest jungle of these hills, and the Nagas say it is in the forests at the base of the hills, but not as abundant as in the hill forests. The juice in the green state and when dried has every appearance of that from the rubber tree. It might be well for Government to ascertain how abundant this forest vine is in the plains and other hill districts of India: also to give a thorough test of the value of the rubber from this vine.—*Indian Agriculturist.*

THE PRICE OF TEAKWOOD, particularly Burmah teak, has risen very much within the past year or two. Logs that could be purchased at Rs. 60 or Rs. 70 per ton, now cost Rs. 140, and it will soon be a question of finding some other timber as a substitute for it. Australia bids fair to supply this, and India will soon be compelled to draw on this colony for her timber supply. An enterprising firm in Madras has imported a consignment, and a Madras paper hears that Government intend to give the timber a trial. A wood that will not decay rapidly on immersion in water, is wanted, and an experiment is, we learn, to be made in the construction of a lock on the Buckingham Canal with this timber. If it should answer, it would soon become a very important item in the imports of the Madras Presidency, as it now is procurable at about a third of the cost of teak, and competition in the trade will no doubt reduce it still further.—*Madras Athenæum.*

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SANDAL.

Santalum album occurs in Mysore more or less abundantly all over the plateau, rarely outside it: rainfall limits of 30 and 50 inches, and elevations above 2,000 and below 4,000 feet. Geographically its area of distribution may be divided into three tracts:—

1st. The western Sandal zone.
2nd. The central scrubs.
3rd. The hill forests.

1st. The western zone of low forest is a well marked tract, eastward of and over-lapping the coffee and (more south) the teak zone. It is limited on the west directly by a rainfall too heavy for Sandal; and indirectly, by the jungle fires which increase in severity, going west, with the increased growth of grass resulting from the increased rainfall. This zone is limited, on the east, by a rainfall tailing down to 25 inches. Sandal is absent in the dry north central portion of Mysore, where the rainfall does not exceed 20 inches.

2nd. The stretches of dry scrubby forests, situated generally on poor gravelly soils, but sometimes on rich deep loams, which are found in the central and eastern portions of the plateau. The Sandal here is often abundant, there being little grass and light fires; but it is of the poorest quality. Where these scrubs are cultivated or much used for grazing, Sandal disappears entirely.

3rd. The ranges of gneiss hills which occur throughout the Mysore country, hills which in height rarely exceed 1,000 feet, and occur sometimes isolated, but usually in ill-defined ranges, running north and south. Many of these hills are rounded masses of solid granite, off which the tropical rain rushes as from the pent roof of a house, to the great benefit of the country around the hills. Suppose, for example, the area of a series of valleys is equal to that of the massive rocky portion of the hills, we have then a doubling of the rainfall for these valleys, and of course a marked improvement in the appearance

of forest vegetation. These hill forests are characterized by patches of nearly evergreen high timber forests, but also by bad grass and bad fires.

Speaking generally the Sandal in the central hill forests of Mysore is of good quality, but natural reproduction is often entirely suppressed by the severity of the forest fires. A remarkable instance of this occurs in the Modgerri State forest, situated 60 miles north of Bangalore, where, over an area of 27 square miles, Sandal is entirely excluded by severe annual fires. In the village grazing lands bordering this forest, where the grazing prevents fires, Sandal is abundant, especially in situations where there is also protection from cattle, such as clumps of thorns. Again, among the hills generally some fine specimens of Sandal are often observed growing in clefts of bare granite-like fig trees; in situations where there is too little surface soil for grass to grow, and where consequently the Sandal is out of the reach of fire. On the summits of the higher hills Sandal benefits by the temperate equable climate which characterizes slight elevations above the plateau; at lower elevations among the hill ranges Sandal profits by the extra rainfall resulting from the rush of water off the bare hills. Sandal from the central hill forests of Mysore is little inferior in quality to that from the regular Sandal zone of the west, but it is less abundant owing to a less easy reproduction.

II. *Requirements as to climate.*—The temperature of the western Sandal zone differs little from that of Bangalore. The northern portion of this zone is slightly lower in elevation; the central portion bordering the coffee districts of Nagor and Manzerabad is the same elevation as Bangalore; the southern portion bordering the teak forests nearly 1,000 feet lower. The central portion of the western Sandal zone has a general elevation of 3,000 feet, and a climate a few degrees cooler than that of Bangalore. The northern and southern portions of the Sandal zone have a temperature very little below that of Bangalore, because although nearly 1,000 feet lower in elevation they lie nearer the edge of the plateau, the ocean, and the prevailing south-west winds. Being nearer, the south-west monsoon lowers the temperature markedly from June to September. Being nearer the ocean and the edge of the plateau gives them the benefit of the sea breeze which alternates daily, after sundown, with the hot wind from the north-east, during the months of March, April and May. The mean temperature of the central hill forests varies within small limits according to elevation. With rare exceptions, the elevation of the lowest valley does not fall below 2,000 feet, nor the highest hill exceed 4,000 feet. The valleys at the lowest limit have a mean temperature of 6 or 8 degrees Fah. above that of Bangalore, and the climate is relatively brusquer, hot winds prevailing by day with cold nights from the downpour of cold air from the hill tops. The hills

have a climate more equable than that of Bangalore, the warm land-heated wind by day being cooled by expansion as it rushes up the hill sides, and the usually still night air (chilled by radiation) flowing off on all sides as fast as it cools. The mean temperature of the hill tops is, according to elevation, at the rate of about one degree Fah. lower for every 150 feet of rise above the level of the plateau. This, I am aware, is double the usual fall of temperature assigned for a similar elevation, but it is derived from observations taken on the Bakabudens, Nandidrúg, Rámandrúg and Dévaraiyadrúg hills. It is well known that the fall in temperature on ascending isolated hills is far greater than that between two plateaux at different elevations. The difference in mean temperature between Madras and Bangalore, for instance, two places situated on plains, one at 3,000 feet elevation and the other at sea level, is 9° Fah., or one degree per 300 feet elevation. But the difference between the mean temperature of Bangalore and that of a well known hill top (Nandidrúg) near Bangalore, and 1,800 feet above Bangalore, is 12°, which equals a fall of *one degree* in mean temperature per *150 feet of elevation.**

In the third Sandal tract, the flat scrubs, the climate is that of Bangalore, allowing for a slight rise of temperature, as the elevation falls from 3,000 feet to 2,000 feet. The following is a description of the climate of Bangalore, extracted from the Gazetteer of Mysore, from Blanford's Meteorology, and from various notes in my possession.

Climate of Bangalore—Temperature.—The mean temperature is 73°, the mean daily range (Puckle's tables) 15°, varying from 12° in July to 20° in February, though it is probable that these last figures are somewhat too low. Between the wet and dry bulbs of the thermometer (at 3-30 P.M. the hottest time of the day) the mean difference varies from 18° in March to 9° from July to October. The mean monthly maximum varies from 88° in April to 75° in December. From August to October, the three wettest months, the mean maximum is 79°. The mean monthly minimum varies from 59° in January to 70° in April: that of the three wettest months is 66°. The following table, compiled from Blanford's Indian Meteorologist, from Puckle's tables, and from the Mysore Gazetteer, gives averages of temperature, of range, of humidity and of rainfall for each month of the year. By 'range' is to be understood the average variation of temperature within the 24 hours, by humidity or dryness of air the average difference between the wet and dry bulbs of the thermometer at 3-30, which is taken as the maximum temperature of the day:—

* The diminution of temperature due to increased elevation is even more marked at Ajmere in Rajputana, where there is a fall of about one degree Fah. for every 100 feet of rise.—[ED.].

Months.	Mean temperature.	Diurnal range.	Rainfall.	Dryness of air.
January, ...	67·4	18	0·00	13
February, ...	70·8	20	0·14	16
March, ...	77·4	20	1·25	18
April, ...	80·4	18	1·42	17
May,...	78·5	18	3·89	14
June, ...	75·1	15	3·97	11
July,...	72·4	12	4·10	10
August, ...	72·2	13	5·84	9
September, ...	72·8	14	5·95	9
October, ...	73·4	12	7·07	9
November, ...	70·7	13	1·05	10
December, ...	67·3	15	0·58	10
Yearly average, ...	73·2	15	35·	12

The regular south-west monsoon blows from June to September, both months inclusive, and gives an average rainfall of 23·75 inches. The north-east monsoon prevails more or less throughout the rest of the year. October is the wettest month of the year, with light variable winds (at Ooty the north-east monsoon is considered to set in about the middle of October). In November there is little wind, but it gradually draws round to the north-east. October with 7 inches of rain and November with 1 inch finish the regular rains. From December to the end of April, both months included, is the settled dry season, producing only 3·39 inches, and this in variable tropical showers. The wind blows from the north-east strongly during the day: the nights are still or with light airs; but a strong south-west current continues to blow intermittently at night, in the upper atmosphere, although it is scarcely felt at Bangalore. There is little wind in May, and the rainfall is usually confined to a few thunder showers, but the south-west monsoon sets in during the month, (generally quite at the end, but sometimes earlier,) and this fact, together with cyclonic falls of sometimes as much as 15 inches, give an average rainfall, equal on paper, to that of a month during the regular rains. But nothing more than a few showers can be depended upon in May, and the spring time of the year for vegetation in Mysore is the month of June, when, as will be seen from a reference to the table, the temperature, range, and dryness of the air fall, almost at once, from their hot weather maxima to the average for the year. But the rainfall, it will be observed, is considerably below the average for the wet months, and herein lies a great obstacle to the success of artificial sowings and plantings, and also to natural

reproduction over the greater part of Mysore. In western Mysore, within the Sandal zone, where the total rainfall does not exceed that of Bangalore, but where the early rains are the more copious, natural reproduction is observably better.

Alternation of Seasons.—Frost in Mysore is unknown; rarely, and in certain situations, minimum air readings of the thermometer have been obtained as low as 32° Fah., but this is purely a meteorological curiosity; and similarly, an honest shade temperature of 100° Fah. is phenomenal. Looking at the table, it will be seen that the marked characteristic of the climate of Mysore is its equability, and for vegetation this equability is even more marked, since as there is no rain in the cold weather, the increased heat of the sun more than makes up for the slightly lower air temperature. Hence, for vegetation, the only alternation of season is from the dry to the wet season.

Sandal is a decided evergreen, and always shows its best growth in situations where the climate is most equable, or where there is a moderate supply of sub-soil moisture throughout the year. These conditions are found in Western Mysore, in the hills of Central Mysore, and everywhere in irrigated or watered gardens where there is moderate shade and moisture. Briefly, it may be stated, that Sandal requires an equable climate, with a rainfall of about 40 inches, and a mean temperature of about 74°, also, probably, some elevation and the full actinic force of a tropical sun.

Soil.—Sandal will grow on any soil, except the most tenacious and undrained, where in fact almost any tree would fail. The finest specimen of a Sandal tree I have ever seen felled, was growing on a sandy bank, by the side of a river, in the western Sandal country. Sandal occurs rarely, and then only when there is sub-soil moisture and drainage, along the banks of the Kabani and other streams which traverse the teak zone of south-west Mysore. There the soil is a stiff vegetable clay, very like what is known as black cotton soil. Sandal again may be often observed growing on the dams of tanks made of a similar tenacious black clay taken from the tank bed. But Sandal delights in a mixed loose soil, such as that which has crumbled down from old forts, and such as occurs in the sites of decayed towns, as at Halébíd and other places. There are no soils in Mysore which contain more than a small proportion of lime, but it is probable, from the fact that Sandal grows on all open soils in Mysore, that it would not refuse to accommodate itself to a calcareous soil. Where there is sub-soil moisture or in a very equable climate, as on hill tops, Sandal will grow in shallow soils or amongst the clefts of granite rocks. Indeed it shows a far better growth in such positions than among the deep, rich, but dry, loams of the plain country. All the soils in Mysore show a large percentage of iron, and possibly iron may be necessary for the full development of the

characteristic scent of Sandal. And here it may be remarked that experience in no way bears out the assertion that the best scented specimens of Sandal are from the most sterile situations. Taking two billets of small size, one say from the gravelly scrub forests, and another from either the western Sandal zone or the central hill forests, the first would be richer in essential oil, because, to become the same size as the second, it would have to be much older. Also the scrub tree would be probably hollow and very knotty, and knots are always dark, full of heartwood deposit and of essential oil. Thus, weight for weight, the scrub tree might show more oil and fragrance, but taking equal ages the scrub tree would be of far less value than the larger sound tree grown under conditions of soil and climate more suited to Sandal. A few years ago I received a specimen of Sandal from the Nizam's Railway forests, the heartwood of which was quite devoid of scent. There is a great similarity of soils in Southern India, and it is probable that the absence of scent in the Nizam's specimen of Sandal is due solely to a difference of climate. I can recall Major van Someren having mentioned some years ago that he had seen Sandal flourishing in some gardens at Surat, but that the wood was scentless and worthless.* Sandal trees may be observed occasionally in gardens and hedges, all over the peninsula of Southern India. In *South Canara it grows in some quantity, and of good scent,* down to very nearly sea level. The artificial rearing of Sandal for planting has shown that humus, or decaying vegetable matter of some sort, is absolutely necessary to Sandal during the first year of its growth, while in the nursery beds. If planted out afterwards on the red loams and lateritic gravels, with scarcely a trace of vegetable soil, on which Casuarina grows so well, Sandal looks starved. And again it has been noticed that it is easier to plant Sandal amongst grown up Casuarina than on a bare soil, and in forest than in the open. There are some good specimens of artificially planted Sandal growing in the yard of the Sandal depôt at Hunsur on old tan pits. I have seen it stated that the Dutch in Java plant Lantana on barren coffee land, which the Lantana enriches by its property of rapidly forming humus. Lantana is one of the few trees or shrubs in the dry climate of Mysore, which form a vegetable deposit akin to humus, and nowhere is there a more striking natural reproduction of Sandal than in the Lantana hedges which are so common round the grounds of houses at Bangalore. In Coorg and Wynád the introduced Lantana has be-

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* We can predicate the same for Sandal at Poona, where the tree grows vigorously, and even reproduces itself naturally in abundance in hedges and gardens on black cotton soil. In the Nimar District of the Central Provinces, Sandal has become all but sub-spontaneous in one locality in the hills south-west of the fort of Asirgarh, but, as far as we know, only the wood of the root is scented.—[ED.]

come a pestilent weed. Last year Mr. Dickinson, the Forest Officer in Coorg, obtained some good results from sowing Sandal amongst Lantana. All these facts point to the conclusion that a soil which contains humus or decaying vegetable matter is essential to the natural reproduction and good growth of Sandal.*

Again, the shade of Casuarina, and its carpet-like accumulation of stalks on the ground, destroy grass and are hurtful to most vegetation; but self-sown Sandal can be observed growing under Casuarina in gardens at Bangalore and abundantly (in a few places where the trees are old enough to have formed humus) in the Government Casuarina plantations to the east of Bangalore.

The most common soils in Mysore are loams varying in colour from a deep chocolate red to a neutral grey. Generally speaking, the deeper these loams are in colour the richer are they in iron and the other mineral food constituents of vegetation. The subjacent rock all over the country is gneiss, usually with the mica more or less replaced by hornblende. In the south the gneiss becomes porphyritic with embedded crystals of a pink felspar. Gneiss may be witnessed in all stages of disintegration; first, the gneiss with the felspar decomposing *in situ*, then crumbling schists, and—when these schists are washed down and deposited by alluvial action—rolling downs of ever-varying loams and long stretches of barren gravels. The hills are composed sometimes of immense masses of solid gneiss, at other times of boulders and granite pebbles of all sizes.

In the western Sandal zone, loams, black clays, schists and gravels occur; and Sandal flourishes wherever it is permitted by grazing and fires, but agriculture usually restricts Sandal to the inferior soils. In the central hill forests Sandal may be observed growing on almost bare granite, provided there be a little humus to cherish its seedling life, and in the valleys on broken stone and thinly spread soils washed down from above. Among the central hill forests, where the early rains are light and often uncertain, it may be imagined that the hygroscopicity of humus is a necessity for the reproduction of Sandal. In the scrub forests which sometimes flank the hills and sometimes form long stretches by themselves, Sandal accommodates itself to miserable soils of gravel and light grey loams; the sole virtue of these soils being that they are usually loose at the surface and sometimes deep. There Sandal is the only tree which is specifically valuable, and the treatment of the forest should be

* In the Banka Barda nursery, Bhaonargarh Reserve, Betul District, Central Provinces, Colonel Doveton, Conservator of Forests, found Sandal seedlings growing as a root-parasite on the wild date-palm (*Phœnix sylvestris*); and such seedlings were more vigorous than others rooted independently in the soil. It would be interesting to enquire whether the greater success of Sandal seedlings in hedges and amongst trees than out in the bare open is not to some extent due to the peculiar habit noticed by Colonel Doveton.—[ED.].

that of regular coppice-under-standard. These scrubs, carefully coppiced, yield good fuel, and the Sandal forms naturally better standards than most of the associated trees.

North and east of Bangalore there is a series of laterite hills. Among these and the derived soils where Casuarina grows so well, Sandal is extremely rare at present.

Locality—Elevation.—There is a specimen of Sandal now in the Bangalore Museum sent by me from amongst several found growing on the banks of the Cauvery, at an elevation of only 1,200 feet. The growth of these trees—thin and straggling, suggests at once that Sandal is here in a climate too hot for it, and that it is on the verge of its natural habitat. But, contrary to what I had supposed, the heartwood of these trees presented an ordinary appearance, and did not appear to be deficient in scent. Growing on the banks of the Cauvery these trees had the benefit of both a sandy open soil and of sub-soil moisture from the Cauvery which is never quite dry. 1,200 feet above the sea is the lowest elevation of any portion of Mysore territory. I have not observed Sandal in Mysore growing more than a few feet above 4,000 feet, but the localities above 4,000 feet in Mysore are so very few, that there is scarcely an opportunity of judging whether Sandal would not grow well at higher elevations. Natural grown Sandal is absent from the top of Nandidrúg, where both shade and moisture abound, the average elevation there being 4,700 feet. There are some fine specimens of Sandal growing on almost bare granite on the top of Dévaraiyadrúg at an elevation of 4,000 feet, Dévaraiyadrúg being the oldest fire protected forest in Mysore. The limits in Mysore within which the tree may be observed in perfect growth are between 2,000 and 3,300 feet for the plains, and 2,000 and 4,000 feet for the hills. I should consider that, except in very exposed situations, Sandal would grow up to 5,000 feet with probably some increase in the density and scent of the wood grown at this elevation.

Aspect.—In a country so near the equator there is little to notice under aspect, but a northern aspect would be slightly drier and warmer than a southern.

Gradient and Configuration.—As already mentioned, Sandal shows no preference with regard to gradient: in the central hill forests Sandal is found in the most precipitous localities, in the western Sandal zone on nearly flat plains.

Dimensions attainable.—The largest tree I have met with measured 8 feet in girth, and gave $1\frac{1}{8}$ tons of heartwood when cut down. This is the tree mentioned already as growing on the sandy bank of a river. This river was the Hemavati, and the tree occurred in about the centre of the western Sandal zone. Even larger trees than this are occasionally met with, but they are extremely rare. The finest specimens of Sandal come usually from the western Sandal zone, but even here specimens yielding heartwood above a foot in diameter are scarce. From

the central hill forests it is rare to get trees with heartwood over 10 inches in diameter, and from the scrubs over 6 inches in diameter.

As regards height, Sandal grown in the open, in hedgerows or over scrub is always a low tree, the average length of bole not being more than from 12 to 15 feet. There is little heartwood in the branches, as they divide rapidly to form the bushy head which characterizes Sandal. Associated with other trees Sandal runs up into long poles, and clean straight pieces of small timber 50 and 60 feet in length, a great contrast to its ordinary stunted looking growth in the open. As regards the total height of the ordinary tree grown in the open, 40 feet may be taken as the maximum, and 20 feet as the average. But in some scrub jungles the average total height is not above 12 feet.

IV. *Habit.*—Sandal may be often observed forking close to the ground. Trees from root shoots, such as those in the circle of suckers, which come up where a Sandal root has been stubbed out, are more liable to divide close to the ground than seedling trees. The average and maximum length of trunk have been given above; a few feet below these dimensions the tree divides into its usually regular rounded bushy crown. Sometimes where shade and moisture are very abundant, Sandal becomes long and sinuous, twining amongst other trees, and taking a form approaching that of a creeper with a thick stem. I have observed trees of this description amongst the Areca nut gardens of Western Mysore, and occasionally in natural forests. For a small tree with small leaves Sandal may be said to have a moderately dense foliage, but it does not throw a dense shade. Where Sandal occurs gregarious in small patches, the tree's own covert appears to be insufficient for its natural reproduction from seed. Between a Sandal tree grown isolated, and a Sandal tree associated with a dense shade-giver, such as Tamarind, there is such a striking difference in the appearance of the foliage, that an observer, at first sight, would hardly recognize the two as belonging to the same description of tree. The tree grown isolated, or mixed with light shade-givers, has a foliage which is scanty or nearly bare in the hot weather, in colour of a light green inclining to yellow. The tree associated with dense shade-givers, has a larger leaf, which is dark green in colour. In dry forests, from an eminence, the Sandal trees can be distinguished for miles around, the very light colour of the foliage of Sandal standing out clear from amongst all other leaf tints. In shaded situations the tint of Sandal attracts attention by its rich dark colour. With the dark tint the leaves are both larger and thicker. This remarkable difference in the appearance of the leafage of Sandal affords some ground for the belief that the tree with the darker foliage and more vigourous growth has joined its roots to those of neighbouring trees, and is flour-

ishing, as a root parasite, at their expense. Dr. Bidie, C.I.E., the Curator of the Madras Museum, was, I believe, the originator of this belief, which has been accepted in some quarters, and is mentioned by Mr. Grant Duff in the botanical notes of his first tour in India.* Root parasitism is a thing difficult to prove or to disprove. That it does occur in certain cases we have the positive assertion of Dr. Bidie that he has dug up Sandal roots and found them to connect with the roots of other trees. Again it is sufficient to cut a Sandal root in the soil at any point to cause it to immediately throw up vigourous suckers, and occasionally when a Sandal tree is cut and the stump stubbed out, such a mass of vigourous suckers are thrown up as to suggest the idea of root parasitism. We know that the roots of Larch do frequently grow together, and unite so thoroughly, that the stool of a cut tree will cicatrice over with new layers of wood. But that Sandal ever commences life as an epiphyte-like plants of the allied order of Loranthaceæ, appears to be a mistake. During the twelve years that the forests of Mysore were under the observation of British Forest officers, no single case of Sandal as an epiphyte was noticed. In Mysore Sandal is the most important forest tree, yielding $\frac{9}{10}$ths of the forest revenue, so that a fact of this sort could not have escaped observation.

V. *Degree of ability to bear shade.*—Sandal, as already remarked, shows the best growth when partially shaded and associated with trees such as Tamarind, which throw a dense shade. When quite young, Sandal will bear the dense shade under old Casuarina trees, a shade which kills grass and almost all ground herbage. I have noticed some good specimens of Sandal trees self-sown on coffee estates in Manzerabad (West Mysore), where the coffee is usually so shaded by tall forest trees that not above one-third the amount of direct sunlight reaches the soil. Self-sown seedlings of Sandal are never observed except in shaded and protected situations. Sandal nurseries *require* a shade of boughs as soon as the fine weather sets in, and when planted out, it is the practice to stick a few boughs round each plant for shade and shelter.

VI. *Persistence of leaves.*—Sandal under the best conditions of growth is uniformly an evergreen. In dry deciduous forests there is a short and partial fall of the leaf towards the end of the dry season.

VII. *Age of fertility.*—Sandal has fertile berries from an early age. I have observed fruit on planted trees when four years old.† Sandal flowers at the end of the hot weather or early

* See foot note above.—[ED.]

† We have observed the same at Poona.—[ED.]

in the rains, and the fruit is ripe in a few months, usually by the close of the rains. In the Sandal nurseries it is the practice to commence sowing in the early part of the rains, with old seed, and if the tile-pots are not fully stocked by the end of the rains, to complete with new seed. Sandal seeds regularly every year, and there is never difficulty in obtaining a supply of the seed. If not gathered at the end of the rains, the fruit speedily falls to the ground and rots, the albumenous pea-like seed decaying with the fleshy portion of the drupe. Old seed swept from the ground rarely germinates well. A small portion of the fruit usually remains on the tree through the dry weather and into the next rains, when flowers and fruit may be seen together on the same tree.

To preserve the seed, it should be gathered or picked off the ground while the fruit is still fresh, spread out to dry, and kept in a dry place for use. Large earthen jars are used for this purpose in Mysore, and attention is of course necessary in the rains, to see that the dried drupe with its enclosed seed, does not become damp and mouldy. Sandal seed prepared in this way and kept for two years, has been used on the Mysore plantations with good result; the opinions of the plantation mistries differ on the question of whether new seed or old seed germinates the better. The first attempts to grow Sandal artificially, on a large scale, failed uniformly, a failure caused to a great extent by badly prepared seed.

VIII. *Facility of germination.*—As a rule Sandal seed does not germinate well, or regularly, as regards time. On an average, Sandal seed takes six weeks to 'come up,' and if in an open vegetable soil and properly supplied with moisture, it will continue coming up for several months afterwards. Ordinarily, in a well tended nursery, less than half the seed sown will germinate, and this failure becomes readily noticeable with Sandal on account of the seed not being small. For instance, it requires on an average a small handful of Sandal seed to produce a dozen plants or to stock two tile-pots. It has been found in practice that the best way to induce a fair germination of Sandal seed is to scatter the seed on the surface of the soil, or to cover it lightly, if the soil is of an open character, and then bury the seed beneath a layer, an inch thick, of leaves, grass, the sweepings of a Casuarina plantation or other vegetable detritus. Half decayed leaves, such as are found under old trees, are the best to employ, if they can be readily procured. If white ants appear in the layer of vegetable soil they may be neglected: they will somewhat hasten the disappearance of the vegetable layer, but they render a service in depositing thin layers of loose soil over the seeds which they do not appear to touch as long as the seeds are alive. The layer of vegetable soil under any circumstances, if properly watered, speedily decays, and has to be partially renewed once or twice in a month. For other delicate seeds I

have found a similar layer of vegetable detritus to be an excellent thing; it preserves the seed at an even warmth and moisture, and its decay supplies readily-assimilable mineral matter to the young seedlings.

IX. *Faculty of growing up from stool and from root-suckers.* —A Sandal tree, if cut a foot above the ground level, or even nearer the ground, gives usually no shoots from the stool in the dry climate of Mysore. But Mr. Cherry, who was for many years Deputy Conservator of Forests in South Canara, has informed me that in the moister, warmer, climate of that district, Sandal stumps left in the ground usually throw up shoots. And the same observation (I may mention here) holds good with regard to trees killed by burning. In the damper districts in the Madras Presidency, a Sandal tree killed by fire is stated to shoot again from the root. In Mysore, Sandal trees in the plantations whose stems have been killed by fire, have invariably died outright; and in forests where Sandal should grow naturally, it is always absent where the jungle fires are severe.

On the other hand, from sections of the root, wherever cut, Sandal sends up shoots with the greatest facility. It is a cardinal point, in the treatment of Sandal, to fell the tree when marketably mature, and to remove the root at once, thereby ensuring a ring of shoots from the smaller roots left in the ground after the root stump has been extracted. A curious circumstance has occurred in connection with this root-shooting property of Sandal: all planting in Mysore is done in large pits usually a yard cube. These pits are dug as labour offers, and left open till the first rains and till the nursery plants are ready to put in. When this pitting is done on soil where there may be already a few old Sandal trees, (say ten to the acre,) at least one-half of the pits will cut some of the long tracing roots of Sandal in the ground: and whenever a Sandal root is cut it sends up a shoot. I have seen a portion of a Sandal plantation where the pits contained as many Sandal suckers as legitimate nursery plants: and Sandal suckers may always be observed in abundance whenever pitting is done near old trees. These numerous suckers considerably add to the appearance of some of the Sandal plantations in Mysore. I have tried on two occasions to propagate Sandal by burying root cuttings; but the success of this experiment is prevented by another well marked property of Sandal which then comes into play, namely, that Sandal roots will under no circumstances stand rough treatment in removal.

(To be continued).

A TALK ABOUT TREES.*

SINCE being invited, some ten days ago, by your Secretary, to attend this meeting, I have been travelling every day, and have had no opportunity for writing, or for making references. I will not therefore attempt to deliver an "address," and must simply attempt to give you, from the abundance of the subject, a familiar talk about trees.

When this country first became known to Europeans, the soil was everywhere, throughout this State, and in all the Atlantic States, and in Canada, covered with forests, until we reach the prairies of the West and the treeless regions of the North. These forests differed greatly in density, and in the kind and value of their timber.

Of course, had these settlers then known all that Europeans now know, or all that we shall hereafter know about forest management, a considerable part of this would have been cleared, in order to make room for agriculture. The parts selected for this purpose would have been the best portions for tillage,—the intervals along the valleys, and the arable portions of the hills and the plains. But the hill-tops and the broken mountain regions, too steep and stony for the plough, and too poor for pasturage, would have been spared. They would have left the forests in the ravines, upon slopes liable to erosion, and upon sands liable to drift. But without this knowledge as to the proper care of woodlands, and without a further thought than to destroy everything alike, and without reservation, except here and there a wood lot, the country throughout the whole settled portion has been cleared, so that there are now but few large tracts of forest remaining, and the valuable timber has, to a very large extent, been cleared off. Much was burned to get rid of it, without any profit, excepting sometimes from the ashes. Forest fires have been invited in to aid in the destruction, and much that was not absolutely wasted without any return has been extravagantly used in needless degree.

This wanton practice has at length begun to attract the serious attention of thoughtful men in every part of the country, and they are asking one another—What shall we do to be saved from the inconvenience and distress which the extreme depletion of these supplies must occasion?

The great seal of Maine bears the device of a white pine tree, and that of your State the figure of a ship upon the stocks. The first of these emblems fitly represented the grandest element of wealth that the State of Maine then possessed; but it has

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* "A Familiar Talk about Trees." Delivered in the Hall of the House of Representatives, Concord, at a Meeting of the New Hampshire Board of Agriculture, on the evening of June 13th, 1883. By Franklin B. Hough, Forestry Agent, Department of Agriculture.

since disappeared from their commerce almost entirely, and in its place we find them using up their spruces and hard woods, which must in time become equally scarce. The ship on the stocks reminds us of a time when the white oak and the white pine supplied the materials for an industry which was once regarded as of commanding importance, and worthy of adoption as the symbol of a State.

I have recently visited Portsmouth, your only sea-port, and they told me that this business of ship-building has died out almost entirely as a private enterprise, and that excepting what is going on now and then at the navy-yard, there is scarcely anything left. At Bath, the principal ship-building point in Maine, where a considerable number of ships are still built every year, the amount of tonnage is far below the totals of former years. They get their white oak from Virginia and other Southern States; their yellow pine from Georgia; their white pine from Michigan; and some of their "juniper" (tamarack) knees from Canada. They are already getting ready to build iron ships at that place, wisely foreseeing in this, a time not remote, when these timber supplies which they are now using will become scarce.

It is true that coal for fuel and iron for naval and civil constructions have in late years largely taken the place of wood; and to this extent they have lessened the demand for wood as a fuel, and for the heavy timbers formerly used in ship-building and in city architecture. But on the other hand, new uses for wood, in various forms, are daily appearing, and among these is that for the making of paper-pulp, of which, already, since a comparatively recent period, a large amount is made; and of this we have as yet scarcely seen the beginning, although nearly forty establishments exist in the New England States alone. Upon the whole, we may say that the amount of wood consumed as a material is increasing every year, while the existing supplies are as rapidly becoming less. I think it need not be proved, for the fact is evident, that although we may, to a large extent, employ stone, slate, tile, brick, and the metals for many uses in which wood is now taken, we can scarcely conceive of a time when this material from the forests will not be in great and constant demand, or when it could ever be less needed than to-day.

Let us for a moment compare the conditions of this country and of Europe, and especially with respect to the titles to land, and notice some points of difference that vitally concern the prospects of our future forests and our timber supplies. With us, the lands in all the older States, and throughout the settled portions everywhere, belong to private owners. Neither the States, nor the general government, nor any county, city, or town, has any woodlands, nor any land upon which forests could be planted. To make a beginning of public forest management, it would be necessary to obtain the title, either by purchase,

gift, or some lapse of title. It is in the most extreme degree improbable that any public authority whatever will ever plant upon private lands, or that any law would be passed, or could be enforced, that should compel the planting of lands by their owners. What remains of our woodlands, as well as all of the land on which the forests once grew, being now held by private owners, it is these owners who must do the planting of the future ; and they will clear their lands, or rear forests, as their self-interest leads them.

Now in Europe we find upon the continent very different conditions. The governments, the communes, or other local organizations, and the public establishments of various kinds, are owners of considerable tracts of forest land, and administrations have been organized to take care of these interests. To get qualified agents for this service they have established schools of forestry. I have visited the forest administrations of every country in Europe that has a system of this kind, and about twenty of these schools, of which there are about thirty. At these schools, young men who have passed their first studies, about equal to what is taught in our academies, are admitted upon examination, and are carefully taught from two to three years in the sciences and the practices that apply to the care of woodlands and the removal and first working of forest products. They are taught mathematics, as applied to surveying, the measurement of contents, estimates of the growth and quantity of timber, accounts, and the like ; the natural sciences that have reference to trees, and to all animal or vegetable life that may effect their welfare. Chemistry, geology, meteorology, mechanics, and, in short, whatever branch of knowledge is useful to the forester, including so much of laws and jurisprudence as may be needed in the discharge of his official trusts. Many of these candidates for the forest service are the sons of foresters, and one of the most talented of the professors of forestry in Europe is the son and grandson of men equally eminent in their profession.

The students in these schools have provided for their use extensive collections of tools and implements, models, cabinets of natural history, laboratories, libraries, forest gardens and nurseries, and the like, and every week they make excursions with their professors to learn from actual observation whatever concerns their pursuits. Once in a year they make a long journey to see forests and operations in planting under other conditions, and of these journeys they keep a journal and write up an account. Finally, after passing examinations that show approved attainments, they become entitled to a place, at first under an experienced forester, and afterwards by themselves ; and they may rise through the various grades of the service, as in our army and navy, with the right to retire on a pension when working days are over.

Among the foresters' duties in Europe are the protection of game and the adjustment of rights of common usage, as, for example, where the inhabitants of a commune or village have a right to fuel, or building materials, or pasturage, and the like, upon their common lands. With none of these affairs relating to hunting or common rights shall we in this country ever have concern. The rights of hunting belong absolutely to the owner of the land, and of rights of common usage we have none.

Now in all of these foreign systems we have nothing to learn from their codes or their jurisprudence ; but we have everything to learn from their methods of planting and management, and from the scientific researches that are being made abroad. We could not give employment to men who were so highly qualified in these special sciences ; we need a less extended but plain and practical course of instruction for a greater number ; in fact, more or less of the first principles throughout the whole of our educational system, even down to the primary schools.

Every graduating class in a college should, at least, have the opportunity of hearing a few practical lectures upon forestry, and in several of our colleges, as in Dartmouth, instruction is now given in the class-room. In schools of less degree, it would be a most profitable thing to inculcate correct ideas, if nothing more, as to the importance of our woodlands in the welfare of the country, and the necessity of preventing injuries and avoiding waste.

As we begin to feel the need, we find springing up here and there inquiries under authority of law relating to the wants and the duties of the future, as depending upon the maintenance of our forest supplies. You have a commission named for the purpose in New Hampshire ; they have one in Vermont ; a little has been done in New York ; and through State and local societies, of one kind and another, our people are beginning to turn attention to this subject, and to realize its importance.

It is not alone the want of wood as a material for ship-building, and erections of every kind upon the land, for manufactories and uses of infinite variety and importance, and for fuel, that is reminding us of this duty. We find effects upon our climate, upon the flow of water in our rivers and streams, and upon our agricultural interests everywhere, which may be, directly or indirectly, traced to the destruction of our forests as a principal cause. Let us briefly notice these several incidental effects, and the manner in which they are produced.

In a wooded country the climate is more humid on account of the great amount of evaporation that is going on from the foliage. The soil is humid because sheltered from the winds and the sun, and the streams are not liable to sudden floods and to drought, because they issue from swamps, or are fed by perennial springs. Let us notice the effect of clearings upon these conditions.

In an open, treeless region, the soil being exposed will sooner dry up after a rain, and if it be clay, it will become hard, so that the rain when it falls will run off at once, instead of sinking into the earth. The water, no longer obstructed by roots and rubbish, does not find its way slowly into the water-courses, but, upon steep mountain slopes and hill-sides, tends to wear ravines, which sometimes become immense chasms, and the rocks and rubbish carried down by the torrents cover the fertile valleys below with stones and gravel, and spread over the plains in destructive inundations that desolate the country far and wide. Finally, the sediment coming down to the sea forms sandbars at the mouths of the rivers, which cause lagoons and stagnant morasses that render a once healthy and fertile region a pestilential waste.

This picture is a faithful one of great regions in southern Europe, and especially in Italy and Spain. In other countries, as in Northern Africa, in Greece, and in Western Asia, we find vast solitudes and sandy wastes, now given up to hopeless sterility, which were once well cultivated by a dense population, and abounding in trees and fruits. We find everywhere in our own country that our springs and wells fail in summer, and that mill-streams once furnishing hydraulic power through the year are almost dry for months together. Rivers once navigable are so no more, and streams depended upon for feeding the reservoirs of our city water-works fail. The snows, prevented from drifting in a wooded country, accumulate in drifts behind fences or fill in the ravines, leaving our fields exposed to frost, and our winter grains to great injury and loss. The insectivorous birds are driven away because they find no shelter, and our fruits fail where they were once as sure as the returning seasons.

Now these facts cannot be denied, and they lead us to the all-important question—What shall be done to prevent further injuries, and to restore the conditions that we have lost?

The first thing to be done is to economize—to use less, and waste less. We have coal, and peat, and iron. We can use these, and stone, slate, brick, and tiles, in a great number of places where we now use wood. We can use up the waste products that are now allowed to decay. We can get tanning materials, when our hemlock is exhausted, by planting oaks. We can provide for future wants by re-clothing our broken lands everywhere with woodlands, and we shall begin to get the benefits, so far as they concern the climate, as soon as the ground is well shaded, although we may have to wait longer for the material that these woodlands should supply.

In travelling through your State—and it is much the same throughout New England and the Northern States generally—I have had frequent occasion to admire the facility with which an abandoned field will lapse again into a forest. You have none of the difficulties that they encounter as we approach the

arid regions of the West in making trees grow. They will grow themselves, and everywhere, if only allowed to remain where they find themselves a chance. But we should bear in mind that some kinds of timber are worth a great deal more than others; that it takes a long time for any trees to become of size suitable for lumber, and that almost always those of least value are of most rapid growth, thus shading out and killing off the more valuable kinds.

Of native species, you have various kinds of oak, ash, elm, birch, maple, linden, beech, chestnut, and others of the deciduous class; and of the evergreens, the pines, spruces, cedars, and the hemlock. It is an easy matter to determine from what has been which of these will thrive to advantage, and it is not worth while to experiment much on uncertainties. We need not try to prove, for this has been done by nature, that the chestnut will not grow on a limestone soil; that pines prefer a sandy soil, if underlaid by a subsoil congenial to their growth; that the maples and the beech avoid the sand and seek calcareous soils; and so on through the whole list.

But besides these native trees, we have within our range of opportunity many not native that will still thrive exceedingly well, some of them bearing seed and propagating their kind as vigorously as in their native home, and others that will grow well enough if helped to a place, but that do not reproduce readily from seed. In Scotland the larch, a native of Tyrol, has been found much more profitable than any of their indigenous trees. The elm in England thrives exceedingly, although its seeds are seldom fertile, and the most precious tree for planting in the North-Western prairie States in some situations is the white willow, which grows best from cuttings or sprouts.

Of trees not native I would suggest the black walnut, hardy catalpa, European larch, Scotch and Austrian pines, and certain of the European willows and alder as well worthy of experiment. They may prove perfectly well adapted to your soil and climate, and some of them, as for example the willows and the alder, a great deal more profitable than our native species. They will at least prove interesting as affording means for comparison and for botanical study, and add new resources to our list, already large, of trees suited for ornamental plantation in our villages and around our homes.

While speaking of exotic trees, it may be remarked that the conifers of the Pacific coast, which thrive so luxuriantly in their native region, almost uniformly fail in the Atlantic States, while the trees of Eastern Asia, the Himalaya region, and Japan, almost uniformly succeed. As these all differ in species, and many of them in genus, from those nearest like them in our own country, we have in these a precious opportunity for increasing an interest in ornamental plantations, and perhaps of adding to our list of exceptionally profitable timber trees.

Let us now come to consider a very practical question, which, at the beginning of your legislative session, may be deemed opportune, namely—How can a State encourage the preservation and restoration of its forests? It is true that individual enterprise, under the stimulus of high prices and the pressure of want, might find it profitable to seek these prices and relieve this want; but our land-owners, upon whom we must depend for future planting, will not begin to do this in a very extensive way until they feel this necessity upon them. It is not wise to wait till these evils are present. It is the part of prudence and foresight to provide seasonably for this future; and in this the State may render important services to its citizens in various ways short of paying for the expenses of planting, and among these the following:—

1. It may exempt waste and vacant lands from taxation for a limited period, where they are successfully replanted and protected for forest growth; or if there be a constitutional provision forbidding the exemption of private property from taxation, as in some of the States, it can declare that the increased value of lands by reason of forest growth shall not be taxed until some revenue begins to accrue.
2. It can stimulate rivalry by the offering of premiums for the greatest amount planted, the best management, or the most approved results in the introduction of exotic species, with reports showing the methods of operation, and other information best calculated for rendering this experience useful to others.
3. It can in like manner reward the authors of essays upon forest culture, and various subjects relating to the maintenance and management of groves and woodlands. To render these most widely useful, they should be printed for distribution among those engaged in planting.
4. It can provide for the establishment of experimental stations for the careful study of methods and the determination of facts of practical utility; and it can aid in this by the distribution of seeds and plants among those willing to co-operate in these observations.
5. It can provide for instruction in the first principles of forestry in the public schools, and to a greater degree in the higher institutions of learning in the State; and in a more general way it can enable agricultural, horticultural, and other societies to extend their operations in the discussion of subjects relating to forestry until special societies for this purpose are established.
6. In can provide laws for the prevention and control of forest fires, under which greater care would be taken in

the use of fires in or near a woodland, and a more direct responsibility attached to this act.

7. In some of the States where this has not been done, the State can enact laws compelling the owners of cattle to keep them within their own premises, thus removing one of the motives for setting forest fires, and tending to the welfare of the woodlands generally.

It is very generally observed that in a new country, and in the absence of an owner or his agent, the rights of property in timber are often disregarded, and it has been appropriated for use without much care or inquiry as to who the owner was. This is especially true with respect to timber upon the public domain, and upon railroad grants. But where groves are planted upon the lands of a resident owner or manager, there would be no greater liability to trespass than in a corn-field or an orchard. As a country becomes older, these private rights become better established. The hardy and sometimes lawless pioneer moves on with the advancing tide of civilization, and personal rights become better defined.

I might say much more that the opportunity allows concerning the amenities of life that are secured in home adornment, village improvement, and city parks, which are so many forms of planting and cultivation, in which the benefits appear in the public health and in the intellectual refinement and personal enjoyment which they secure to all who come within their influences.

We are accused by Europeans of being an unstable and restless people, having no strong attachments to ancestral possessions, and ever seeking new fields of enterprise in an uneasy desire for change. There is nothing that can more strengthen this attachment to home and country than by making them pleasant. It is only those who feel this attachment, that build monuments and that found institutions that will survive them as witnesses of their substantial interest in the welfare of the country in which they have lived.

I have faith in the Yankee! I believe in him! If you can only tell him where there is a dollar to be made or saved, *and make him believe it*, he will find the means to secure it. Now one of the ways of doing this is to plant trees. When planted, protect them. Teach the importance of this, and the methods by which it can be done to most profit, in your schools and colleges, and especially let every owner of land seek to advance this object, both by precept and example, and it will not be long before we shall begin to realize the advantages that should result from this measure.

SILK CULTIVATION IN THE PUNJAB.

IT appears from the reports submitted to the Punjab Government during preparation for the Calcutta Exhibition that in that Province the Native silk industry is declining. The unadulterated silks of Native looms are gradually giving place to mixed silk and cotton goods imported from England and other European countries. These mixed fabrics of many colors and of gaudy hues find much favour with the unæsthetic Native who cares little for wear-resisting qualities of silk. Sericulture is practised but rarely among Natives, the silk used in the looms being imported in a raw state from Bokhara, Ladakh and Bombay. From the imported silk, articles of great variety are made, including turbans (which are greatly in demand), purses, waistbands, *phúlkáris*, and the brightly embroidered table covers, cushions and such like, which the mendacious Kashmiri pedlars have made so well known to Europeans. While, however, the Native silk industry is declining, the European silk cultivation carried on by the firm of Lister and Company in the Punjab at Gurdaspur, and in the North-West Provinces at Dehra Dún, appears to be in a flourishing state. Four varieties of silkworm have been domesticated, the Kashmiri, the Chinese, the Japanese, and the Assamese. The Kashmir and Japan varieties are the best suited to the climate of Upper India, the eggs being univoltine, *i. e.*, hatching under ordinary conditions only once in the year. The time of hatching is the spring, when the mulberry tree throws forth its new leaves, and the worms can only be reared so long as a plentiful supply of juicy leaves is forthcoming. In the plains it generally happens that the heat of the weather causes the eggs to hatch before the mulberry leaves have appeared; and as no other leaf provides suitable food, an insuperable obstacle arises to the general cultivation of the Kashmiri or Japanese worm. The Chinese variety of silkworm is bivoltine, the second hatching taking place almost immediately after the worms of the first hatching have spun their cocoons, and at a time when a supply of succulent leaves is almost unattainable. The second hatching is consequently useless, and the productive powers of the worm are wasted. The Assam silkworm is multivoltine, and has the further peculiarity of feeding on the leaves of the castor oil plant. It has not yet been domesticated in the Punjab, but has recently been reared on a small scale with much success at Dehra Dún under the careful management of Captain J. Murray. Cottage cultivation of silk has been abandoned by Lister and Company as a decided failure, and under present arrangements the agents of the firm carry on personally the whole process from hatching the eggs to reeling the cocoons.

PRACTICAL ENSILAGE.

In August 1883 a silo was constructed in the Allahabad Fort, under the orders of Major General Sir H. Macpherson. A subterranean chamber, used in ancient times as a dungeon, was selected for the purpose, and into it was thrown a large quantity of rank grass, the first growth of the monsoon. The predominating varieties were *Andropogon Bladii* (janéwar) and *Pennesitum cenchroides* (angan), both well known as excellent fodder grasses. The grass was cut, not scraped up, and much of it was thrown dripping wet into the silo. When enough had been filled in, a layer of white *bhúsa* was spread over the top to the thickness of about an inch. Over the *bhúsa* were laid a number of old railway sleepers, and over the sleepers were piled some 28 tons of round shot. The average weight was about 280 lbs. per superficial foot. No attempt was made to compress the grass before laying on the weights; and no salt was added, as most authorities insist should be done. The silo was opened after a period of nearly six months. The upper layer of grass had solidified, and could only with great difficulty be cut open. The ensilage came away in sheets or layers. Its general colour was a greenish yellow, and much was very moist, and a strong vinous and acid smell was perceived. During the six months the grass had sunk to about half its original depth. The ensilage was issued as fodder for the siege train bullocks, 20 lbs. being given to each animal daily. Captain Wingate, who describes the experiment, says that the bullocks ate the ensilage readily. Mules and horses looked upon it with some suspicion; goats refused to eat it; but cows and calves fed upon it eagerly. The experiment may be said on the whole to have been most valuable, showing clearly that it is possible with great profit to store for future use the rank vegetation of the rains. The market value of ensilage is stated to be about 12 annas a maund.

IV. Notes, Queries and Extracts.

Jarrah Timber.—As the subject of Jarrah timber is receiving prominent attention at the present time, and some valuable notes were supplied in our issue of February 23rd from Western Australia, it may not be out of place to supplement the same by a review of what was known by us of this wood in our home literature. Mr. Thomas Laslett, Timber Inspector to the Admiralty, in his valuable work "Timber and Timber Trees, Native and Foreign," says:—

"The Jarrah, or Mahogany Tree (*Eucalyptus marginata*), is found in Western Australia, where it is said to be very abundant. It is of straight growth and very large dimensions, but, unfortunately, is liable to early decay in the centre. The sound trees, however, yield solid and useful timber of from 20 to 40 feet in length, by 11 to 24 inches square, while those with faulty centres furnish only indifferent squares of smaller sizes, or pieces unequally sided, called flitches. The wood is red in colour, hard, heavy, close in texture, slightly wavy in grain, and with occasionally enough figure to give it value for ornamental purposes; it works up quite smoothly, and takes a good polish. Cabinet-makers may, therefore, readily employ it for furniture, but for architectural and other works, where great strength is needed, it should be used with caution, as the experiments prove it to be somewhat brittle in character.

"Some few years since, a small supply of this wood was sent to Woolwich Dockyard with the view to test its quality and fitness for employment in ship-building; but the sample did not turn out well, owing to the want of proper care in the selection of the wood in the Colony. The shipping officer sent only such small squares as might have been produced from logs cut or quartered longitudinally, which left in each case one weak or shaky angle, instead of sending the full-sized compact square log representing all that the growth of the tree would give. It is just possible, however, that this was unavoidable, since it may be inferred from the nature of the conversions that the trees from which they were cut commenced to decay at the centre at or about mid-life, and they had become hollow at the root-end of the stem long before they arrived at maturity. This remarkable defect being characteristic of the Jarrah tree, it follows that no compact and solid square log beyond the medium size can be obtained of the full growth, and hence the conversion of the faulty trees is necessarily restricted to the dimensions of flitches cut clear of the centre.

"One peculiarity was noticed in the sample referred to, some of the logs had cavities or blisters, varying from one to several inches in length in the longitudinal direction of the woody layers, and spreading from 1 to 3 inches concentrically, which occurred, like the cup-shake, at various distances from the pith, and at intervals of a few

feet along the line of the trunk of the tree. These cavities were partially filled with a hard secretion of resin or gum, which made up in some measure for the solidity, although it did not impart the strength which would compensate for the deficiency of the cohesive properties common to the annual layers.*

"From what has been stated respecting the Jarrah timber received at Woolwich, it will readily be supposed that the authorities there did not look upon it with favour, or any desire to employ it for ship-building purposes. It therefore passed to some of the minor services of the yard, and it was while under conversion for these ordinary and inferior works that I took the opportunity of making the experiments which are given in detail in the following tables:—

Jarrah (Australia).—Transverse Experiments.

Number of the specimens.	Deflections. With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.	Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1,000.	Weight required to break one square inch.
	Inches.	Inch.	Inches.	Lbs.			Lbs.
1	2·85	·10	4·50	743	987	753	185·75
2	3·25	·15	4·50	638	1,049	608	159·50
3	3·25	·15	5·00	661	977	677	165·25
4	3·50	·15	5·00	661	1,039	636	165·25
5	3·15	·10	4·50	726	1,006	722	181·50
6	3·25	·15	4·75	685	1,002	684	171·25
Total, ..	19·25	·80	28·25	4,114	6,060	4,080	1028·50
Average,	3·21	·133	4·71	685·66	1,010	1,608	171·416

Remarks.—Each piece broke short.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion 1 square inch.
	Inches.		Lbs.	Lbs.
7	2 × 2 × 30	987	10,080	2,520
8	2 × 2 × 30	1,006	13,440	3,360
Total, ..	..	1,993	23,520	5,880
Average, ..	..	996	11,760	2,940

Vertical or Crushing Strain on Cubes of Two Inches.

No. 9. Tons.	No. 10. Tons.	No. 11. Tons.	No. 12 Tons.	No. 13. Tons.	No. 14. Tons.	Total Tons.	Average Tons.	Do. on 1 square inch.
12·875	13·000	12·625	12·750	12·750	12·750	76·75	12·792	5·198

* This peculiar defect is met with in several of the Eucalyptus species, and may occasionally be seen in the firs and pines.

"It is a noticeable fact, in connection with the experiments, that all the specimens tried proved deficient in strength and tenacity, by breaking off suddenly with a short fracture, under an average transverse strain of 686 lbs. weight only, or about 171·5 lbs. to the square inch of sectional area.

"Since the foregoing was prepared I have seen some correspondence between the Home and Colonial Governments on the subject of Jarrah timber, and also between the Governor of Western Australia and the leading ship-builders and ship-owners, including Lloyd's surveyor at Freemantle, who had been severally asked to report upon the merits of the Jarrah, with a view to getting it recognised at Lloyd's.

"Most of the ship-builders and ship-owners have reported very favourably, and speak of it as a good description of wood. They say that when used with iron fastenings neither material is in any way injured by the other, and also, what is a little remarkable, that it bends well without steaming. In speaking of its merits, however, they nearly all do so under some reserve, such as insisting on the felling being done at a certain time of the year, getting it from some particular district, and so forth. Lloyd's agent at Freemantle, however, does not report quite so favourably of it; indeed, he differs so widely from the rest, that perhaps it would be well to quote his report *in extenso* :—

"'In reply to your letter relative to the qualities of the Jarrah of this country as a ship-building timber, I consider it valuable wood for planking purposes as high as the wales, and I also consider it especially excellent wood for small craft which are not intended to be sheathed with metal, inasmuch as it resists the sea-worm better than almost any other wood, and is less liable to foul; but I do not consider it suitable timber for top sides or deck work, where it must necessarily be much exposed to the effects of the sun, it being, in such positions, more than ordinarily subject to shrink and warp, and it is rather deficient in tenacity of fibre, so that in situations where eccentric or sudden bends occur it cannot generally be employed with advantage. It is probable you may have heard of the Honourable East India Company's pilot brig *Salween* taking in a cargo of Jarrah at Bunbury. This was supplied by Mr. W. Pearce Clifton, and the vessel was sent at my instance, in order to a series of trials of the wood, in the Kidderpore dockyard. These trials, I regret to say, were not favourable to the character of the wood, and the result was that no further supply was ordered.

"'When last at Calcutta I obtained the sanction of the Government of Bengal to further tests of the wood, the greater portion of the *Salween's* cargo being then still in store, but I am sorry to say that the result was not more favourable than before.'"

"The Clerk of Works at Freemantle, reporting summarily upon the opinions expressed by the ship-builders and others, says :—

"'The sound timber resists the attack of the 'teredo navalis' and 'white ant.' On analysis by Professor Abel, it was found to contain a pungent acid that was destructive to life. The principle, however, was not found to be present in the unsound portions. Great care is therefore necessary in preparing the wood for use, by flitching the log so as to cut all the defective portions of the heart out, and using only the perfectly sound timber. Very much has been said about Jarrah

being subject to split when exported to India or England in log. It must be borne in mind that its density renders seasoning very slow, and that the inner portions of the larger trees are in a state of decay even while the outer portions are in full vigour. A tree under these conditions, the inner portions comparatively dry, and the outer full of sap, shipped at once to a hot climate like that of India, or to such a variable one as that of England, very naturally bursts from unequal shrinkage, being also exposed to very great changes of temperature. To obviate this peculiarity and apparent defect, let the Jarrah be felled when the sap is at the lowest ebb, and flitched as previously suggested.*

"'I have seen it stated in some correspondence from Western Australia that a specimen of Jarrah timber has been chemically examined by Professor Frankland, with the view to ascertain whether there is any peculiar acid or other substance present in it calculated to resist the attacks of 'teredo navalis.' It does not appear, however, that anything of the kind has been found which could be credited with the effect referred to. It is believed by the Professor that the singular immunity from attack which this wood enjoys is due either to the odour or taste it possesses. These, though by no means remarkable or repugnant to the human senses, are probably strongly so to the 'teredo navalis.'"

"From the foregoing statements it will be seen that there is great diversity of opinion upon the merits of Jarrah timber, and time only *will show whether, if imported, it will find favour with ship-builders* and others in this country.

"Some three or four years since (about 1871) the Western Australia Timber Company were busily engaged in the forests preparing a large quantity of Jarrah for exportation. The Company professes, I believe, to select only the best trees, and to cut them at the proper season; the deliveries should therefore be of the very best sort the country produces. *I have earnestly looked for sample cargoes* to arrive in the London docks, but up to the present (1875) none of any importance have been reported."

Our next author is Thomas Allen Britton, late Surveyor of the Metropolitan Board of Works, in his valuable work "A Treatise on the Origin, Progress, Prevention, and Cure of Dry Rot in Timber," who says :—

"The Jarrah wood of Western Australia is considered a first-class wood for ship-building, but it is somewhat slow to season, and if exposed before being seasoned is apt to 'fly' and cast. The methods adopted in seasoning are those of salt water, sea sand, and seaweed, of which the following are the details :—The logs are thrown into the sea and left there for a few weeks: they are then drawn up through the sand, and after being covered with seaweed a few inches deep, are left to lie on the beach, care being taken to prevent the sun getting at their ends. The logs are then left for many months to season.

* The Committee of Lloyd's have recently had the subject of Jarrah under their consideration, and determined to class this timber with those in line 3, Table A, of the Society's rules; thus ranking it with *Cuba sabicu*, pencil cedar, &c., for the construction and classification of ships.

When taken up they are cut into boards 7 inches wide, and stacked so as to admit of a free circulation of air round them for five or six months before using them.

A late Western Australian almanac says: "None of the neighbouring colonies possess timber of a similar character to the Jarrah, or endowed with equally valuable properties. If cut at the proper season, when the sap has expended itself and the tree is at rest, it will be found the most enduring of all woods. On this condition it defies decay; time, weather, water, the white ant, and the sea worm have no effect upon it. Specimens have been exhibited of portions of wood which had been nearly thirty years partly under water and partly out. Others had been used as posts, and for the same period buried in sand, where the white ant destroys in a few weeks every other kind of wood. For this peculiar property the Jarrah is now much sought after for railway sleepers and telegraph posts in India and the colonies. It is admirably adapted for dock gates, piles, and other purposes, and for keel pieces, keelsons, and other heavy timber in ship-building. Vessels of considerable burthen are built entirely of this wood, the peculiar properties of which render copper sheathing entirely unnecessary, although the sea-worm is most abundant in these waters."—*Timber Trades Journal.*

THE WOOD BUSINESS IN RUSSIA, ON THE TWO RIVERS DNIEPER AND BEREZINA.—To a stranger coming to Russia, who has seen wood business managed in other countries, the manner of going to work here certainly excites no small degree of surprise. One sees evidently it is the way that things were carried on in the time of our forefathers, and that new ideas have not found their way yet to this out-of-the-way part of the world, where every one seems to expose a shield against any new inventions, or any new improvements.

Still business is done here on no small scale; the mass of wood yearly floated down on these two rivers is something immense. From the moment, in the early spring, when the ice melts and the rivers rise some 10 or 16 feet above their usual level, one sees the rafts coming down in a succeeding mass.

Like all business in this part of Russia, the wood business is in the hands of the Jews. Owners of estates and forests sell part of their wood to them, and they know how to make the best of everything that comes into their hands. Winter begins here generally in November. In September, when the peasants have to pay their taxes, contracts are made up with them, when generally those who are living together in small villages agree, and bind themselves, against an advance, to cut and drive a certain quantity of wood down to the banks of the rivers. These advances are sometimes a third or one-half of the amount they can expect to earn during the course of the winter, but when signed by the elected members of the court of the village, or the Starosta and the Uradnisk as they are called here, one hardly ever risks anything by giving them advancement.

In November the peasants come to the woods, sometimes with one, sometimes with two, sometimes with three of their small pony-like horses, in the last case called *troskas*, collecting together often as many as 200 to 300 horses from one village. A sort of abode for the winter is then erected in the woods, built of small poles, earth, and straw, which reminds one more than anything of the huts of the Esquimaux and the Laplanders. The building is made in the following manner: earth is thrown up and made to a round flat cake, 1 foot high, and 12 feet to 15 feet in diameter. On this platform poles are placed so that it gets the form of a sugar-loaf. On the poles, which admit of a little hole in the top for the smoke to escape, is laid straw, and on the straw earth and sand; and on the side of this extraordinary arrangement there is an opening made in order to come in and out of this Russian mud-house. When ready 12 to 15 men make it their home for the winter. Furs, rags, and little boxes for provisions are placed all round, and the fire composed of large logs, and the large saucepan is in the middle. When the work of the day is over, and the workmen place themselves each on his place round the flaming fire, on which the soup, composed of meat, cabbage, and onions, boils, then is the time to see the Russian native, and hear his monotonous chant, reminding one of the inhabitants of some wild country. As for him, having no delicate nerves and his smelling organs seeming to enjoy the heavier and thicker the smoky air gets, he puts his rags round him, stretches himself out on the sandy ground, and, unmindful of storm or cold, sleeps the sleep of the innocent, till the morning light, which wakes him up, and reminds him it is time to put the primitive harness, generally made of rags and rope, on his poor half-starved horses, and go to his day's work again.

The cutting and driving is done in this way, and every peasant has his axe. He cuts down his tree, cleans it from knots and branches, lays it on his sledge, and drives it down to the river. So millions of trees come down to these two rivers in the course of the winter.

The sort of wood growing here is a sort of fir redwood, sometimes also whitewood. The fir tree grows here very fast. A fir tree which would want 120 years and more to get ripe in the north of Europe wants here only 80 years. It is, however, coarse, sometimes sappy, and contains a mass of resin and other glutinous matters, which makes the least knot of a bright red colour. To see the trees standing in the forest is a fine sight when they are straight, and grow high without branches, but cut them down and the charm is gone. Those masses of blocks, quantities of firewood, and birch, elm, alder, beech, and other kinds of wood, are being forwarded down the river during the entire spring and summer; most of it to the Black Sea, with the exception of a little part of it which is taken up against the

river to the Baltic. Most of the blocks are formed into large rafts. Holes are made in the end of each of them, and they are tied togather with bands of willow. This is a clumsy and an expensive way of constructing rafts, besides cutting away two to three feet of each log. Two or three rafts are then tied together with willow bands, a little wooden hut is erected, sometimes hardly larger than a dog kennel, on which is a tiny pole with a bit of red or blue cloth as a flag. The three or four men who are in charge of this raft make this their home for the six or seven weeks, sometimes more, they are on their way to the Black Sea.

Another way of transporting different kinds of wood down the rivers is in the large lighters, sometimes called Berliner, sometimes Barkar. The former are very strongly built, but the latter are of enormous 60 to 80 feet long planks, large enough to load 200 to 300 standards, and only built for the one journey down to the Black Sea, where they are taken to pieces and sold. I had an opportunity of seeing both of these kinds of lighters built last winter. It was a queer sight to see three such Berliners building, each large enough to hold about 120 standards. There can be no doubt that in like manner the men-of-war must have been built some hundreds of years ago, when many battles were fought here between the Russians and the wild tribes from the east and south of Russia. The boards used were 5 to 6 inches thick, 15 to 20 inches wide, 50 to 60 feet long, hand-sawn out of one block of the finest trees found in the woods. Thousands of the most beautiful oaks were cut down and made into lighters, each in value equal to what one could buy a nice sized schooner for. Still more wonderful was the building of the barque, which was a sort of Noah's Ark as to size. How they got this enormous structure to hold together and keep tight is something I cannot understand, more especially as it was built to pass the cataracts between Kremenchuek and Cherson. Most of the timber is being sent down to Cherson, Nikolaieff, and Odessa, only some part of it is sold on the way at Kief and some other places. In Cherson are large saw mills, where a great many of the blocks are being transformed to deals and boards, another part of the blocks are being shipped from Nikolaieff and Odessa in the form of square timber.

There are some saw mills in this part of Russia also, but they are as old fashioned as everything else, where some thousands of blocks yearly are sawn to large boards, mostly all of one size, and sold at so much a piece at Kiew.

In this part of Russia there exists a decided feeling against foreigners, or one is nearer the truth in saying that the Russians hate strangers, and with the dim idea they have of what is right and what is wrong, they consider it their duty to persecute them as much as ever lies in their power. Cunning and intrigue seeming to form their character, they can no doubt do a great

deal of harm to any one coming down here who is unprepared, and not knowing what sort of people they are.

In the end of 1882 a wood-exporting firm in Finland made an agreement with a Count v. M., in St. Petersburg, who was the owner of a large estate with extensive forests in this neighbourhood, to take out the value of the woods for joint account. The forests contained about a million of trees, ripe for cutting, and these were to be made into money in as short a time as possible. Plans were made; a saw mill with six frames and a planing mill were to be built, and 80,000 trees were ordered to be felled the first year. The trees were felled, the saw mill was built, workmen were collected from Sweden, Finland, and Riga. Last summer the saw mill was so far ready that sawing began, when the firm in Finland unexpectedly came into difficulties. Money was not sent to pay the workmen. Some time after the firm in Finland was made bankrupt, and the owner left for America. The Count v. M. stopped payment in the real sense of the word, and there the poor workmen were left with their wives and children in utter want of money, in an exceedingly dangerous climate, where fever and illness came more regularly than the daily bread, without means to buy medicine and without a medical man to attend them. Death visited them through typhus, and they had to bury their dead themselves, the Roman Catholic clergymen asking an impossible price to read the service.

To tell of all the intrigues, all the unfulfilled promises, and the mean behaviour on the side of the Russians against these poor people would be of no use. Suffice it to say that by their common efforts they got over the first part of the winter, and now, through the help of the Swedish Ambassador and the Finnish authorities in St. Petersburg, they were sent home to their respective countries, penniless. The business is entirely wound up, and the very fine saw mill, with its first-rate machinery and every new improvement, is standing waiting for a new owner who may have sufficient means to make himself independent of Russian intrigues, and be able to continue a business which began so hopefully a little more than a year ago.

My intention, in referring to this business, is to warn strangers not to try their luck in Russia without being backed by people whom they thoroughly know and can have entire confidence in.—*Timber Trades Journal.*

PRUNING FRUIT TREES.—The principal use of pruning is to preserve the symmetry of the trees, though in closely planted orchards it is necessary to prune to keep the trees within bounds. Pruning for either of these reasons is easily accomplished, but there are other reasons for pruning which only the man of experience and scientific acquirements can properly understand.

Supposing an ordinary pruner was sent into an orchard to prune, his endeavour would be to carry out either or both of the above-named purposes, and he would therefore probably prune the hardest those trees that had made the most wood, and leave unpruned or lightly pruned those that had made little or no wood; while the man of experience would be likely to act in a directly opposite manner; he would be aware that the trees making the most growth were the least fruitful, while the others had probably borne more than they could bring to a first class condition. His object, therefore, would be to reduce the bearing propensity or power of the latter, and by the same means increase their power of growth; while in regard to the former he would endeavour to check their exuberant growth, and induce them to become more fruitful. The over-prolific trees he would prune hard, thinning out a large proportion of the fruit-bearing spurs, by which means the supply of sap the roots were able to send up the following spring would be less divided, and each remaining bud would receive a larger share than it would have done had the whole of the buds been allowed to remain and claim their share. The result would be that each bud, having received an extra supply of sap, would make stronger growth and more foliage than before; the leaves, by reacting upon the roots, would cause a great extension, and so the vigour of the tree would be increased; the enlarged number of roots sending up a constantly increasing supply, both shoots and fruit would benefit thereby. That such results would be obtained may be seen whenever a tree, whether aged, decrepit or young, is headed down; the superabundance of nourishment, finding a limited demand, becomes used up in the formation of wood of vastly increased strength, while any fruit there may happen to be is proportionately enlarged. In this climate the fruits of cooler countries are forced, as it were, by the, to them, unnatural amount of heat and light, into a condition of precocity, which, if not checked, must necessarily end in weakness; the endeavour should therefore be to counteract the tendency to precociousness and maintain the tree in a well balanced condition, producing no more fruit than it can bring to full maturity, and a due proportion of wood for the maintenance of that condition —a suitable and properly cultivated soil, with due supplies of manure, being, of course, understood. The difficulty of attaining the desired result is sometimes greater in the case of an over-luxuriant, and therefore partially or quite barren tree, than in the opposite case, especially when it happens to have an unlimited root run. Trees in such a condition not unfrequently continue to receive the usual amount of pruning year after year, thus producing such an exuberance of sap that blossom buds cannot be formed, except on a few weak and pinched spurs, and increase so slowly in number that it requires many years before the tree is brought into a full-bearing condition;

whereas, if such a tree is left altogether unpruned, it would certainly become fruitful either the next or the following year. The aim, then, should be to maintain a fair balance between the production of wood and fruit, and if the nature of the variety to be operated upon is known, a scientific pruner can soon establish, and afterwards maintain his trees in that condition, by checking over-luxuriance, and encouraging the formation of fruit buds, or the contrary, as may be necessary. Much good may, in many cases, be effected in checking over-luxuriance by summer pruning, for if the young growth of the most vigorous tree is continually stopped, its vigour will presently be reduced, and even its health may be impaired, if the process is carried to an extreme. Summer pruning is generally neglected, partly from ignorance of its good effects, and partly because orchardists have little leisure at that season. It is, however, of great value, especially in the formation of useless wood that has to be cut away at the end of the season, and increasing the strength of that which has to remain.—*Leader*.

Timbers for Tea Boxes.—One of the lightest woods we have is Simal (*Bombax*) or cotton tree, and I have known whole chests made of it weigh only 12 lbs., though the wood was half an inch thick. It is however liable to split if it receives hard knocks.

One of the best woods for boxes is Roghu, formerly Nauclea Kadamba or Kodom, *Anthocephalus Kadampa*,—called Kodom in Bengali, and Halamba in Sinhalese. When seasoned it is fairly light, strong, and tough. In Assam it generally has a tolerably straight, clean stem 30 to 40 feet long, which is continued up through the head or crown, the latter composed of a mass of *radial* branches.

As a rule the head of foliage is domed, and the lower branches have a tendency to droop and hang down all around. Roghu is one of the very few trees that generally carries its stem, of central axis, right through the crown to the very summit: and when young it is very symmetrical.

Externally the bark is dark brown or grey, and fissured by cracks longitudinally; inside it is a brown or dark dim color. When young, the bark is particularly clean and smooth, and of a pale grey green.

There is no heart, and the wood is yellowish white, soft and even in texture, easily cut, whether green or seasoned. The leaves are stiff, large and entire, pointed, and with short foot-stalk; on old trees they are from 8 to 10 inches long by 5 or 6 inches wide. They are much larger on young trees, and I have measured one 31 inches long by 20 inches wide, on a one-year old plant 10 feet high.

The flowers are small and clustered in a ball, 2 inches diameter, that ripens about October.

Roghu has several peculiarities worth recording; the growth is remarkably rapid for the first 6 or 8 years, becomes slower on to 20, and then is very slow. During the first 2 or 3 years it grows some 10 feet per annum in height, while the girth in same period is often an inch per month. I have cut 10 inch planks for boxes out of Roghu only 8 years old, and am now felling a good many that are 16 years old, and at 6 feet up, measure (an average of 5) to 5 feet 5 inches girth, while at 30 feet up they measure 3 feet 8 inches in girth. Up to 8 or 10 years old it grows so rapidly as to be worth planting, but after 15 or 20 years, is so slow that it is most profitable to fell when about 12 years old.

Another peculiar feature of this tree is the difficulty of propagating it from seed, while at the same time it springs up in millions naturally on new clearances. I once estimated that I weeded out 450,000 Roghu seedlings on 25 acres of clearance. Taken altogether this tree is one of our best for tea boxes, both on account of its natural qualities as a wood, and as a tree; and the pity seems that it is not more extensively grown by Planters and Government, especially as it takes such a short time to reach useful size. It is on this latter account I place it first *on the list of box* timbers.

In my last I drew attention to Roghu, or Kodom, formerly *Nauclea Kadamba*, as one of our best box timbers, also to Sotiana, Chutni, or *Alstonia scholaris*, and Pati honda, which is *Cinamomum obtusifolium*. I omitted to notice that the last is called obtusifolium perhaps in consequence of the way in which the points of the leaves are damaged.

I have frequently searched the foliage of a felled tree for an entire leaf, and generally failed to get even one perfect,—all seem eaten by some insect. It would be interesting to know if this peculiarity is local, or common.

Poma—*Cedrela Toona*, or the tún tree, before noted, is an excellent box-wood; it is both light and strong, though not very tough; unfortunately it is not a very common tree, and if used for boxes, the supply would likely run short. It is easily propagated, and grows rapidly, so that it is a good one to have in reserves. It is apt to split in felling, unless care is taken. Poma boxes weigh about from 20 to 25 lbs., and this is not the same wood that comes to us as "Cedar" from Burma: the latter is heavier, harder, and less attacked by white ants.—S. E. P.—*Indian Tea Gazette.*

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SANDAL.

(*Continued from page 210*).

X. *Mode of Growth.*—The first appearance of Sandal above ground is the elbow of a slender green loop, the cotyledons remaining below the ground folded in the shell of the seed. As soon as the loop unbends, and the cotyledons appear above ground, they are liable to be eaten by insects, and insects continue their attacks most vigorously on the young tender leaves during the first year of the plant's existence. The young Sandal seedling, a few months old, has a tap root comparable to a young radish—a bundle of fibre surrounded by soft cellular tissue. This soft cellular tissue is very liable to be attacked by grubs: I have lost many plants from this cause both amongst *in situ* sowings and amongst nursery plants in pots. During the first year Sandal in nurseries should grow about 10 inches in height, (this is the contract height in the Mysore plantations,) but want of attention in keeping the plant supplied with leaf manure and water will give sickly yellow plants, not more than 4 or 5 inches in height, at the end of the first year. On good soil, in a yard cube pit, Sandal should be from 1 foot to 2 feet in height at the end of the second year from seed; and when planted side by side with Casuarina, the Sandal will occasionally be higher than the Casuarina; but this rapid growth is not maintained beyond the first few years, and there are always considerable differences amongst Sandal trees of the same age and growing side by side. When young, Sandal has to contend with many enemies, and at the end of two or three years there are more differences in the appearance of the growth than with Casuarinas or Blue-gums at the same age. The smooth succulent character of the leaves of Sandal doubtless contributes to render them the favourite food that they are for hares and deer. When planting Sandal it is usually necessary to place thorns over each plant to keep off hares. If spotted deer are abundant in the locality, it becomes necessary to fence plots of Sandal

planting. Self-sown seedlings of Sandal are rarely seen except amongst clumps of thorns or other bushes, where they are naturally protected from browsing.

When grown up out of the reach of hares, deer and (in village grazing grounds) goats, Sandal trees are still too often sufferers by their branches being broken off for fodder.

Compared to Casuarina, or to Teak, Sandal is undoubtedly a slow grower; but in the central hill forests of Mysore it is a fast grower compared to the excessively slow growth of the indigenous species with which it is associated. It has been also observed to shoot up rapidly amongst high forest trees of good growth which exist on the dry side of the zone of coffee cultivation in Mysore; but here again, it has been remarked that after a few years the growth becomes so slow as to be scarcely observable. In 1875 when in charge of the Hassan Forest Division, I cut dates of the year "1875" so as to just pierce the growing cambium layer, on several Sandal trees, near the Forest Lodge, in the Baktarwalli Sandal plantation. I noted the position of these trees, and left directions that they should not be felled. Their age from appearances was near the period of their commercial maturity, a period which I reckon practically as the time when the heartwood comes to within 2 inches of the bark, in an old looking standing tree, or more exactly, in a cut tree, when the proportion of heartwood to sapwood is as 4 : 5, measuring the section across an average radius or diameter. I next visited the Baktarwalli plantation in 1882, and found my three trees untouched. The slight wounds made in cutting the date had grown over, but indistinct scars on the bark showed where the bark had been cut. I then made sections with a knife down on to the old wood, when "1875" became clearly visible. The thickness of the superimposed layers, and of the surrounding layers of tissue, which scarcely differed, was then measured, with the following result, transcribed from an official report made at the time:—

In tree No. 1, large but still in vigorous growth, the average thickness of the new formation of wood was 0·10 inch.

In tree No. 2, which in size and apparent age, was very similar to No. 1, the average thickness of new formation of wood was 0·11 inch.

In tree No. 3, which was situated close to No. 2, but which was older and evidently making little growth, the average thickness of the new growth of wood was only 0·06 inch.

Thus for two trees apparently in full growth, but approaching maturity, the average increase in diameter per year per tree was only $\frac{0''{\cdot}10 + 0''{\cdot}11 \times 2}{6 \times 2} = \frac{0''{\cdot}21}{6} = 0''{\cdot}035$. For a tree already mature the same figure was only $\frac{0{\cdot}06 \times 2}{6} = 0''{\cdot}02$. This last tree is an example of the loss resulting from leaving a mature

tree standing. During the last 6 years the addition to the diameter of the tree was only 0·12 inch, *i. e.*, the growth was practically nil; but the loss, represented by the forfeited interest (at 5 per cent.) of an unemployed capital (assuming the tree to be worth Rs. 30 as it stood), would be Rs. 14. For a graphical representation of this loss on an acre supposed to be fully stocked with Sandal, *vide* "Indian Forester," Vol. III., No. 4 of 1878.

Until within the last three years the Sandal plantations in Mysore were stocked by *in situ* sowings in shallow pits. As will be explained subsequently, the resulting stock was too irregular to furnish figures of growth, and the only accurate information in my possession on the rate of growth of Sandal is that which I obtained on enquiring into the history of certain individual trees, in prominent positions, near some villages, where I happened to be encamped some years ago with spare time on my hands. The results of this enquiry were published in the "Indian Forester" in the paper mentioned above. In that enquiry the history and age of 15 isolated Sandal trees were minutely recorded, and calculation made of the different ages at which these trees would be mature supposing them felled—

1*st*, at the period of their commercial maturity;
2*nd*, " " " physical maturity.

The enquiry was made with the object of obtaining some information on the commercial and physical maturities of Sandal, and the data are not sufficient to determine the cubic content of the heartwood, and consequently the rate of growth, for more than 12 trees. The individual-increment for these 12 trees is 0·141 cubic foot as follows:—

Individual-increment of 12 Sandal trees grown in the Hassan District of Mysore: elevation 3,000 feet: rainfall 35 inches.

No. of case in paper "Notes on Sandal."	Cubic content of heartwood in cubic feet per tree.	Age of trees up to commercial maturity.	Individual-increment in cubic feet per year.
1	2·11	40	0·053
3	1·73	43	0·040
4	10·44	55	0·190
5	10·34	35	0·295
6	2·96	28	0·106
8	7·21	50	0·144
Mean allowing for the number of trees in each case,	...	...	0·141

Leaving out the trees in cases (1), (3) and (6), which were bad specimens, the individual-increment for the remainder is 0·166 cubic foot. Probably, till more figures are available, 0·15 cubic foot per annum may be taken as the bulk of Sandal formed by a tree in good growth, and cropped at the period of its commercial maturity. In the above calculations sapwood and bark are left entirely out of consideration.

Artificial propagation.—From 1868 to 1878 the artificial propagation of Sandal in Mysore was exclusively by means of direct, or *in situ*, sowings; and it was not until the introduction of tile-pot nurseries, that regular planting was attended with any certainty of success. *In situ* sowings, as regards the percentage of established plants, gave the poorest results, but by going over the same ground for 6 or 8 years in succession, a stock was eventually established, and there are now in Mysore about half a dozen Sandal plantations, which were formed in this way, and which are now more or less completely stocked: there is about an equal number where *in situ* sowings, continued for several years and giving purely negative results, was eventually abandoned. In the drier eastern climates of Mysore, *in situ* sowings of Sandal have failed, equally with that of every other species which has been tried, and almost every indigenous tree of value *has* been tried. In low-lying arable land, which can be repeatedly ploughed, trees can be easily raised from *in situ* sowings, though the after-growth is poor and scrub-like; but the forester's place in Mysore is among the stony ranges of hills which intersect the plateau at all points, and here, with *in situ* sowings, the best results have been obtained by putting seed in small patches dug to a depth of 8 or 10 inches. It is preferable to have the patches as close as possible, on account of the small percentage of patches which will remain finally stocked; and the more the patch of worked soil approaches a foot cube pit, the greater will be the percentage of established plants. Pits of any size for *in situ* sowings would be casting pearls before swine. But without pits, the mere sowing of seed in patches, is such a simple and inexpensive process, (usual rate 400 patches per rupee,) that it naturally commended itself from the first to the attention of foresters in Mysore, and received a thorough and conscientious trial. The results were these—

In the large plantations to the north and east of Bangalore, on flat scrub-covered land, *in situ* sowings of species indigenous and exotic were definitively abandoned after three or four years thorough trial. These trials were resumed by me in 1877 and 1878, with a variety of precautions too numerous to mention here, and the result was that *in situ* sowing was finally and definitively abandoned. In these experiments Sandal was sown in the open and under shade, in patches, and in pits of all sizes up to the standard yard cube pit.

In the central hill forests the result of *in situ* sowing of

Sandal and other species was substantially the same, except that where there was more shade the germination was better. But there was no improvement in the percentage of established plants, apart from a few exceptional cases, where there happened to be a good supply of sub-soil moisture.

In the western Sandal zone, where the early rains are heavier, *in situ* sowings have the best chance of success. In two plantations in the Hassan District, Ijapur and Baktarwalli, where the success of *in situ* sowings was sufficient for the system to be continued for nine years, the following results were reported by me, on visiting these plantations recently.

Extract from an official Report to the Dewan of Mysore, dated August 1881 :—

* * * * * *

"Sandal sowings have been practised at the Ijapur and Baktarwalli plantations for the last nine years. Year after year the old ground has been re-trod with a hopeful persistency similar to that with which Amildars enter on work of this description. The nett result is, that Rs. 9,589 have been spent, and that 3 per cent. is a liberal estimate of the number of patches which contain seedlings. Of these 3 per cent., more than half are of a size smaller than the ordinary one year old plants from a tile-pot nursery. Mr. Stephens, the local Forest Officer, agrees with me in thinking that 2 per cent. at Ijapur and 4 per cent. at Baktarwalli, represent the average percentage of patches with seedlings in them. We have spent four days in examining this work. On taking charge he wisely stopped further expenditure on Sandal sowings. I should add, that of its kind, there is no fault to find with the work that has been done. I was gratified to find the sowings for this year in such a forward state. Financially too, this Rs. 9,589 has not been thrown away : 3 per cent. on 181,500 patches gives 5,445 trees, and Mr. Stephens informs me that he at one time counted 50,000 trees at Baktarwalli. There is about 15 acres there on the top and side of a hill where the Sandal looks well. Both these sites are within the influence of the beneficent early rains of the south-west monsoon, and Baktarwalli is good high-timber hill forest. The rate for patches, stated now to be 550 per rupee, is moderate; *but the work not having been regular, nor charged rateably, the old* accounts cannot be verified. Thus the result of *in situ* sowings, carefully conducted for nine years, is a success of $\frac{4}{9} = 0{\cdot}44$ per cent. per annum on a good soil (Baktarwalli): on the poor soil of the Ijapur reserve $\frac{2}{9} = 0{\cdot}22$ per cent. per annum.

* * * * *

The following extract from the same inspection report relates to the Naihalla Sandal plantation, and is an example of the best results attained from the *in situ* sowings of Sandal in Mysore :—

"*Naihalla Sandal Reserve near Bettadpur, Ashtagram Division.*— This plantation has been stocked exclusively by *in situ* sowings, as have Baktarwalli and Ijapur; but the patches have been made twice as close (a yard apart here) and more seed put in each patch. Still

more seed than has been used here would have been better—see my Forest Notes. More favorably situated for supervision, the Sandal at Naihalla presents a far better appearance than the similar tracts in the Hassan District. On entering the enclosure, Sandal is observable everywhere, from the weakly seedlings of last year, carrying on a very unequal struggle with the prolonged drought of the present season, to strong trees 10 and 15 feet high. As elsewhere, the best trees are in the clumps of thorns and bushes.

The following are percentages of stocked patches, counted at intervals as I walked through the plantation:—

Percentage enumeration at Naihalla.

Brought forward,	149	254	
10	8	5	
40	40	12	
12	12	3	
8	6	10	
6	3	9	
3	6	8	
8	6	11	
4	5	6	
8	6	7	
20	4	7	
22	5	6	
8	4	4	
149	254	36) 342	Total.
		6) 9·5	
		Mean 1·6	per cent. per year of patches stocked.

It will be observed that there are considerable variations, and that on an average 9·5 per cent. of the patches are stocked. The work has been repeated here for six years, so that the yearly percentage of the successfully stocked pits is 1·6. This, for *in situ* sowings on a poor soil, is a very fair result. The work appears to have been creditably done, but not rateably: and there is no information with regard to rates available in the Mysore District office. The plantation was begun in 1875, and I have the expenditure on it each year since; but there having been no working-plan, it cannot be stated exactly what area has each year been treated. The area of the plantation is *considered* to be 96 acres: the total expenditure has been Rs. 4,433, or at the rate of Rs. 46-2-10 per acre. This, considering that the area carries a fair stock of Sandal, is not a high rate—considerably

less I believe than what the same description of work has cost the Madras Government. If 9·5 per cent. of the patches are stocked, there are now just under 4½ lakhs of young Sandal trees in the plantation. Assuming the stock complete, and that 300 trees per acre come to maturity, the present selling value (discounting at 5 per cent. compound interest, taking the maturity at 45 years and the *nett value 45 years hence per tree at Rs. 50) would be Rs. 1,78,560.* Rs. 50 as the nett value of a forest-grown Sandal tree is a safe estimate, Rs. 30 being the nett average value of a Sandal tree grown in both favorable and unfavorable localities. The only doubtful figure in this estimate is the maturity period. If this extends to 60 years, as some of my enquiries seem to indicate, the discounted present value would fall to rather under a lakh of rupees. In considering the future fire-protection of this plantation, it must be remembered that its discounted *present* value cannot be much less than, and may considerably exceed, a lakh of rupees; and that for some years to come a bad fire would destroy nearly the whole of the Sandal. The stock, worth about a lakh now, will be worth about two lakhs in 15 years, but by that time many of the Sandal trees will be of a size to be badly injured, but not killed by one fire. Thus, as the value of the stock increases, the disastrous effects of a fire would become less, but the latter will not keep pace with the former, and until the plantation is of an age to admit of cattle being turned in in order to get rid of the grass, no pains should be spared to secure it from fire."

* * * * * *

Of the heads given under *in situ* sowings, (1) and (2) have been discussed. As regards (3), the best time for *in situ* sowings is the beginning of the monsoon, as soon as the early south-west showers have moistened the ground. The western Sandal zone has this advantage over the central hill forests and the scrubs, that the early rains from the south-west monsoon are usually sufficient to ensure the germination of seed; and thus the resulting seedlings are five or six months old when the dry season sets in. But in the other two classes of forests, there may not be sufficient continuous rain to germinate Sandal until the autumn, so that the dry season finds seedlings two months old and kills them in a fortnight—in the open. Sandal seed, sown in patches, is very liable to be eaten by rats and insects, especially in the eastern forests, where the germination is delayed and uncertain. I have combated this by soaking the seed in sulphate of copper and assafœtida.

(4), A Sandal plant which has withstood one dry season is very unlikely to perish the second, because, if unwatered after one dry season, it is an established plant with a long tap root.

Several weedings of a light description are necessary in the western Sandal zone. In the other two classes of forests, weeding is unnecessary, or is limited to once inverting the sod of grass which may form round the young plant.

Watering.—Watering, whether in the case of planting or of

in situ sowing, is impracticable in Mysore, except on the most limited scale. Watering is the kernel of the whole matter of artificial propagation in a dry climate like that of Mysore. The successful system of planting which has been followed in Mysore for some years, hinges on the fact that it has enabled us to do *without watering*. *With* watering any system of planting or of *in situ* sowings will succeed; it is "gardening" as distinguished from "forestry." Watering in a dry climate is equivalent to hot house culture in a cold climate. I have seen so-called experimental plantations which were really gardens; there was a staff of gardeners, and each gardener had so many plants which he visited and hand-watered daily.

Now, in Mysore, it is generally extremely difficult to get a sufficient supply of water for even the nurseries if they are on a large scale. An ordinary well will not yield an unfailing supply of water for more than 30,000 *closely packed tile-pots; and the* digging of a well is always an uncertain operation. If one is fortunate enough not to encounter stone, the well may have to go 60 feet into the loam before water is reached. Nursery wells of this depth are of course impracticable: a nursery well is usually stopped when a depth of 30 or 40 feet has been reached without finding water. A fresh site for the nursery has to be then looked for. Over a large area of the western teak forests of Mysore, the sub-soil water is at such a depth as to render well digging impracticable. Here, for want of water, nurseries are almost impossible, except near a few streams. Watering transplants is of course quite out of the question. In the open plains, where there is more sub-soil water *in the dry season*, it is safest, where practicable, to locate the well and nursery within the influence of a large tank. Except near very large tanks the finding of an unfailing supply of water for the nurseries is always extremely difficult; so difficult is it that in the choice of sites for nurseries every consideration has to give way to that of the water supply. A curious fact may be mentioned here, namely, that in the immediate vicinity of the old established Casuarina plantations, it is more *difficult to get water by well digging*, than in the open plain country around; and the same observation has been made with regard to the Cantonment of Bangalore, where a large quantity of Casuarina and other evergreen trees have been planted. As the evergreen trees have grown up the well water level has sunk. With these remarks, I proceed to describe the system of planting which has been perfected in Mysore for Casuarina, and which has been found to be the only system applicable to the planting of Sandal on a large scale, Sandal being a difficult tree to transplant, and one which during many years it was declared could not be planted. The essential points of this system are, that the plants are raised in tile-pots, whence they are put out in yard cube pits *without disturbing the roots*. The planting out is thus merely a continuation of the

plant's life in the nursery. The planting out is done during the early monsoon. As soon as the rains have set in, the plant is transferred from its tile-pot in the nursery to its cubic yard of freshly filled-in earth in the plantation. It then grows rapidly, *with a deep root-growth*, during the monsoon rains; and the first hot weather finds it with its tap root more than 3 feet below the surface, and thus almost comparatively out of the reach of drought.

The tile-pot is formed by placing two semi-cylindrical country tiles together edge to edge, so as to form a cylinder, about 5 inches in diameter and 10 inches long. The cylinders are placed together side by side in previously excavated beds, till they form a honeycomb filling the bed. Earth is then shovelled into the honeycomb of tile-pots, filling the whole up flush with the surface of the ground. To facilitate counting, each bed usually contains 100 tile-pots—10 rows of tile-pots, 10 in a row. The beds of tile-pots are separated only by narrow paths, just wide enough to permit the formation of the channels by means of which the beds are irrigated, the water being raised from the well by a pecotah. It matters little whether the seed is sown broad-cast over the beds of tile-pots, or pricked out into the tile-pots from little beds of sand, which are convenient for germinating seed. The former course is usually adopted with Sandal, it being extremely sensitive to removal; while Casuarina is germinated in beds of sand, and pricked out into the tile-pots when it is from 1 inch to 2 inches in height. The price of common roofing tiles in Mysore, such as are used to make the tile-pots, is from Rs. 4 to Rs. 5 per 1,000 cylinders or pairs of tiles; each pair of tiles making a cylinder or one tile-pot. When the system of planting from tile-pots was first introduced, the two tiles were tied together with string, grass, &c., but this was soon found to be unnecessary. The earth in the tile-pots, during the six months or a year that it remains in the nursery, necessarily cakes to some extent with the constant watering, and the plant becomes also what gardeners call "potbound;" so that when the transplants are removed from the nursery, the plant, rooted in its cylinder of earth with the tiles enclosing the earth, comes out in one piece. The tiles adhere sometimes so firmly that it is difficult to remove them from the cylinder of earth without breaking them; but usually one of the tiles can be easily lifted off, or it will come off with a little tapping and coaxing with a stick. The nursery cylinder of earth, supported on the remaining tile, is then put into the hole in the ground prepared for it, the pit earth pressed firmly round, the remaining tile withdrawn, and the transplanting is done. Sometimes the cylinder of earth from the nursery is so hard that both tiles can be removed without fear of breaking it: the nursery cylinder of earth then goes into the ground without having a pebble shaken. This may be regarded as the perfection of

planting; it usually occurs during a spell of dry weather, that is to say, exactly when good planting is most required.

In large forests, where bamboos are abundant and potters scarce, tile-pots are economically replaced by bamboo pots. The two advantages appertaining to the use of pots in dry climates are—*1st*, the saving in the area of the nursery; this is a consideration when watering is reckoned at so many square yards per rupee per month; *2nd*, the ease with which the cylinder of earth can be extracted from the nursery—a cylinder, small in diameter but deep, and in which the root, confined at the side, has already taken a deep development.

In introducing tile-pots in planting operations, the cost of the tile-pots has to be set against a saving under these heads —*1st*, in the cost of watering the nursery; *2nd*, in the cost of carving out with spuds, the large cylinders of earth surrounding the roots when the latter are left unconfined in the nursery;* *3rd*, in the reduced cost of carriage from nursery to plantation; eight plants in tile-pots weigh no more than two with large cylinders of earth carved out of the nursery which was the old system of transplanting. Tile-pots cost from Rs. 4-8 to Rs. 5-8 in Mysore delivered on the nursery, free of breakages. The average life of a good tile-pot is 5 years. The total saving in the cost of planting after the introduction of tile-pots in Mysore was Rs. 15 per 1,000 plants transplanted. We may reckon the cost of tile-pots per annum at about one rupee per 1,000. Thus the nett saving, by the use of tile-pots, was Rs. 14 per 1,000 transplants.

The essential conditions for successful planting in a dry climate seem to be—to encourage and to protect the tap root while in the nursery, and to plant it out in a large pit of freshly dug earth as soon as there is sufficient rain to moisten this earth. In a dry climate we plant *with* the tap root; in a moist or in a temperate climate one cuts off the tap root to avoid the trouble of caring for it, and planting is done with the superficial fibrous roots which replace the cut tap root. With Sandal, as I have already remarked, there is no choice about accepting or cutting the tap root. The young Sandal seedling from the time it germinates is difficult of removal; and to injure the tap root in the smallest degree is to kill the plant. In the Sandal nurseries it is usual to strew a layer of broken bits of old tiles at the bottom of the beds, and on this is set the honeycomb of tile-cylinders, so that any unusually long tap root passing downwards cannot grow beyond the tiles.

Sandal seed is sown in the nurseries as soon as the tiles are emptied of the previous year's plants. A dozen or more seeds

* This "carving out," including the cost of the entire process of lifting up the plants out of the beds, need not cost, if proper implements are used and the daily wage of a man does not exceed 4 annas, more than Rs. 2 *per mille*.—[ED].

should be put in each tile-pot, or the seed may be sown broadcast and thickly over the honeycomb of pots. The seed is then lightly sprinkled with loose earth, and over this is strewn a layer of old leaves, grass, or other half decayed vegetable refuse, which must be renewed constantly during the ten months or a year that the Sandal plants remain in the nursery. This vege table layer should never be less than an inch thick. The seed will germinate slowly, and fresh seed must be put in till every tile-pot has a little bunch of Sandal seedlings. Any tile-pots still left empty may be stocked by very carefully pricking out seedlings. In spells of dry weather, during the monsoon, water must be given *sparingly*. Anything approaching a swampy condition of the nursery will damp off the seedlings. If the locality becomes flooded during heavy rains, as of course must happen sometimes near tanks, the only remedy is to lift up the tile-pots from the beds, and set them side by side, to dry in the air. This entails trouble and expense, and the flooding of a Sandal nursery is undoubtedly a calamity to be foreseen and provided against in choosing the nursery site. The rains over and watering in full operation, which usually occurs about the beginning of December, a light shade of boughs should be put up over the Sandal nursery: a shade which will stop less than one-half the direct sun light at midday is preferable. Too much or too little shade, or too much watering, will render the young Sandal plants liable to suffer from leaf disease. Leaf disease sometimes commits great havoc in Sandal nurseries. The leaves turn yellow, and drop off one by one from below upwards. The Sandal plant becomes a bare stick with a struggling terminal bud, and is thereby retarded in its growth if it is not killed outright. Leaf disease may occur at any time, but it is most to be feared towards the end of the young Sandal plant's sojourn in the nursery just as the monsoon is setting in. I know of no remedy for it except attention and care on the part of those in charge of the nursery. If the soil of the nursery gets into bad condition, caked at the surface, or sodden either from careless watering or inattention to the constant renewal of the surface layer of leaf manure, leaf disease will invariably make its appearance. The three things to be especially borne in mind in a Sandal nursery are—1*st*, light watering; 2*nd*, light shade; 3*rd*, the maintenance of the layer of leaf manure by renewal every two or three weeks. Healthy Sandal should grow at the rate of nearly an inch a month while in the nursery, and be thus a strong plant about 8 inches high, with a tap root 10 inches length when the monsoon sets in, and it has become time to put out the transplants from the nursery into the pits which have been prepared for them in the plantation. It remains now to speak of pits.

The use of large pits in planting is common amongst the natives of Southern India, where occur wide plains of indurated

loams characterized by low sub-soil moisture. These loams abound in iron; they are an intimate mixture of clay and sand such as is employed in plastering and brick making: more clay would make them crack in the dry season and swell up in the wet; less clay would prevent them binding. Tropical sun and rains do the rest, and the result is a soil as hard as a macadamized road during nine-tenths of the year. To break up this hard layer for planting, we must employ either *very* deep ploughing, or the simple expedient of digging a pit and filling in the earth again. A Forester has little to do with ploughing (unless he poaches on arable land), hence, if he is a planter on these hard plains, he is a great digger of pits, and if he wishes to avoid watering, he digs a deep pit. A cheap and simple steam-digger is a desideratum, though it is difficult to imagine any machine able to compete with the cheapness of manual labour and the dearness of fuel. Mr. Robertson of the Madras Agricultural Department speaks very hopefully of an American digger lately introduced. I have tried experiments with blasting pits, and with pits formed by driving in steel tubes with a mallet. The first plan is expensive, and has other and obvious objections. The second requires further experiments with tubes increasing in size; pits so formed would be too small for Casuarina, but large enough for Sandal.* But it is difficult to imagine any improvement where yard cube pits can be dug at the rate of 32 cubic yards per rupee, which is the common monsoon rate in the large Casuarina plantations in Mysore. I have on several occasions made experiments, and lately on a large scale, in order to determine whether the yard cube pit is really the most economical size that could be adopted. Pits of different sizes were dug in compartments lying side by side in the same plantation. These compartments were planted up in the same manner and the results watched. To the digger the advantage of the yard cube size of pit is, that the coolie gets into the pit and digs it out large and square at the bottom, exactly where it is most important for root development that the pit should be roomy. Casuarina is such a rapid and greedy grower, that up to 4 or 5 feet cube "the larger the pit the larger the tree" is a rule which is strictly true. To dig pits on a large scale, bigger than a yard cube, is impracticable on account of the expense; but it appears to be false economy to attempt to reduce the pit below a yard cube in size in the case of Casuarina on hard loams. For Sandal, which has a much slower growth than Casuarina, the most economical size of pit appears to be one 2 feet cube or 2½ feet cube according to the cost of digging the pits. But pits of this size are in disfavour with the coolies and pit contractors, and in the only

* We should say that the stronger kinds of soil borers used by foresters in Germany would do the work expeditiously and at a trifling cost.—[ED.]

locality in Mysore where Sandal planting has been prosecuted on a large scale, Sandal and Casuarina are planted side by side, so that it would cause confusion to have two sizes of pits. Thus almost the whole of the Sandal planting which has been done in Mysore is in yard cube pits. In these plantations Casuarina is planted now 9′ × 9′. The early planting of Casuarina alone, by Major van Someren and Mr. King, was 15′ × 15′, and this, which has been recently measured, has given surprisingly favourable rates of average growth, both per acre per annum and per annum per average tree. The advantage of the closer planting is that it lessens the danger from fire in a mixed plantation of two species so extremely sensitive to fire, as are both Casuarina and Sandal. I anticipate that such of the present 9′ × 9′ planting as is available for measurement 7 years hence, will give a higher acre-increment, but a lower individual-increment than the old wide 15′ × 15′ planting. For a mixed plantation of Casuarina and Sandal I should consider 9′ × 9′ as the most favourable distance for planting.

If yard cube pits are spaced 9′ × 9′ they have the advantage that the space left from pit edge to pit edge being only 2 yards, is nearly covered by the soil excavated from the yard cube pit. With a very little extra trouble, all intervening ground between the pits may be covered with the earth thrown out of the pits, and the old grass covered and killed. Thus, afterwards, when these pits are filled in for transplanting, the soil around the young trees is clean, which of course is an advantage with all trees, and, with a rapid grower like Casuarina, helps the early suppression of the grass. It should perhaps be added, that pits in the Mysore plantations are dug as labour offers and when the ground is favourable for pitting; there is thus necessarily almost always a large balance of empty pits on hand, and it is an advantage that the soil excavated from the pit should remain for some time exposed to the atmosphere. But before working-plans were introduced, this large balance of empty pits was one terrible source of confusion. Sandal as has been already noticed, should not be planted pure, but mixed with some good shade-giving species—*1st*, because Sandal is a shade-lover, and a lover of more shade than is afforded by its own leafage; *2nd*, it flourishes best in a vegetable soil which its own foliage is not capable alone of forming; *3rd*, it requires shelter when young; *4th*, there is the doubtful quality of root parisitism.

Glancing through the heads under which information has been asked, there remains little to be added under Sandal planting.

With regard to weeding, what has been said under *in situ* sowings applies equally to planting. Light weedings are necessary for a few years in the western Sandal zone; in the central hill forests and in the scrubs no weeding is necessary, or weeding need not extend beyond raising and inverting the sod, which may have formed and filled up to the surface of the pit

around the transplant. A sod raised with a spade or a monati, and replaced roots uppermost, takes a year or two to decay, and in the meantime keeps clean the ground so covered.

Watering for plantations on a large scale, as has been remarked, is only practicable for a short time, and very partially during the monsoon rains, and until the plants are established. Putting pits against watering, pits have the advantage (and it is an inestimable one in large operations) that pitted areas can be immediately checked with the compartment areas borne on the working-plan. Watering on the other hand is a loose operation, which cannot be checked on a large scale. Secondly, watering brings the young tree's roots to the surface; it is a *demoralizing* operation, which once indulged in must be continued! Pitting on the contrary simply assists nature, encouraging the deep root growth which is characteristic of all trees in a dry climate, especially evergreen trees such as Casuarina and Sandal. In the mixed Casuarina and Sandal plantations in Mysore, watering has been entirely abandoned for many years. The area of these plantations up to the end of 1881 was 3,872 acres, or 6 square miles. "Repairs" or "replacing failures," with an average season and average soil, does not exceed 15 per cent., and the rate for replacing failures is a very low one, namely 270 per rupee, since all that is necessary is to place a second plant in the pit where a previous one had failed.

As with *in situ* sowings, the first hot weather is the critical period. The planting is considered to be established when the first hot weather is passed, *i.e.*, after the transplants have been about a year in the ground.

Sandal sowings have been tried with gingelly (*Sesamum orientale*), castor oil (*Ricinus communis*), and with other plants as nurses, but the results were not sufficiently favourable to invite a repetition of the experiments. Doubtless the shade afforded by these plants as nurses is beneficial to the Sandal; but the drain on plant food and on sub-soil moisture is similar to that of very energetic weeds. Even a few castor oil plants, which were raised recently for shade in a tile-pot nursery, were found to injure the growth of the Sandal near them.

Sandal cannot be propagated from cuttings: root cuttings, which would seem likely to succeed, are in practice a failure. To this account of Sandal planting in Mysore, is appended a copy of rates* current, and of the planting rules* or conditions, handed to each contract mistri, when he is employed. It should be stated that all work is done on contract, at the maximum rates here shown; it is measured up and passed monthly by the Ranger in charge, and checked by working-plans, in which each plantation is divided into blocks and compartments, the

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* These unfortunately have not survived the voyage to the Southern Hemisphere, which was the fate of this paper after it was written.

quantity of work charged in a compartment being checked against its survey area : the nature and progress of work is shown on the working-plans by colouring—yellow for pitting, green for transplanting, dull red for areas too rocky to pit, &c.

Planting is being done now in nearly equal proportions of Sandal and Casuarina : Sandal takes the larger share of the planting, as there is much sparse Casuarina, which can be filled in with Sandal, at an enormous enhancement of the value of the stock. There are slightly under four lakhs of tile-pots in the various nurseries in Mysore, and planting in an average season progresses at the rate of between two or three lakhs of transplants.

D. E. HUTCHINS.

The following note just received from Mr. A. E. Lowrie, Assistant Conservator in charge of the Ajmere forests, supplies most interesting information, and makes a very substantial addition to the life-history of the Sandal given by our distant friend Mr. Hutchins :—

" Last year I noticed some (to me) strange looking trees in the Nág Pahár and Mohwa Bír blocks near Ajmere, but took no trouble then to find out what they were. But recently, seeing how well they were getting on in spite of the severe drought this year, I concluded that they would be useful trees to grow in suitable localities throughout the Ajmere forests, and so I set about determining the species to which they belonged. No flowers and fruit being obtainable at this season, and the old leaves being shed while the new flush is only just coming on, the only certain means of identification left for me was to fell one of the trees and examine the wood. I accordingly selected one that was 23 inches in girth. The section showed a core of heart-wood 4 inches in diameter, which gave out the unmistakeable odour of Sandal.

" This was a very interesting discovery. On going over the ground and making enquiries of people able to afford information, I find that there is a small area in each of the above-mentioned blocks, which was formerly a garden, and in which a few Sandal trees were planted some 20 or 30 years ago. These have now grown up and seed profusely every year. The seeds get carried away into the forest by birds and bats, and many seedlings (about 400) of various sizes have been springing up in the midst of bushes, some of them already over-topping these latter. It is a noteworthy fact that some of these seedlings have come up *in the driest localities with barely a foot of* soil over the underlying quartzite. All the seedlings have an exceedingly healthy appearance.

" In the case of only a single pole have I been able to collect certain data regarding its age and rate of growth. It is 12 feet high, 9 inches in girth and 8 years old. It is growing right in front of the Mohwa Bír Chauki in very poor and rocky soil, but has had the benefit of a little watering from time to time.

" I am informed that the Sandal here flowers early in May, when the new flush of leaves is well advanced."

THE SANDAL WOOD OIL STILLS OF SOUTH CANARA.

THE distilling of sandal wood oil is an industry of very long standing in the Udipi táluq of the South Canara District, but no attempt appears to have been made to bring it under control or secure a revenue from the firewood made use of until 1854. The arrangements then made by the Forest Department were continued till 1874, when they were held in abeyance until 1881, pending the enquiries then instituted regarding the respective rights of Government and private proprietors over the South Canara forests.

The manufacture of the oil did not, however, cease, but a legitimate revenue was lost to Government, and the forests were being rapidly destroyed for want of proper regulations and practical measures of conservancy. During this period the stills were scattered about all along the foot of the ghâts, and there was a great opening for smuggling of sandal wood from Mysore and Coorg. Now they are in a compact block in the villages of Andár and Mutlapádi, and every precaution is being taken to protect and improve the forests by defining the areas and working them in rotation, and to guard against any smuggling of sandal wood from Mysore, on detection of any part or connivance in which, the license to manufacture is liable to be immediately cancelled.

A recent inspection enables me to give the following information as to the method of manufacture, which may be found interesting by readers of the Forester.

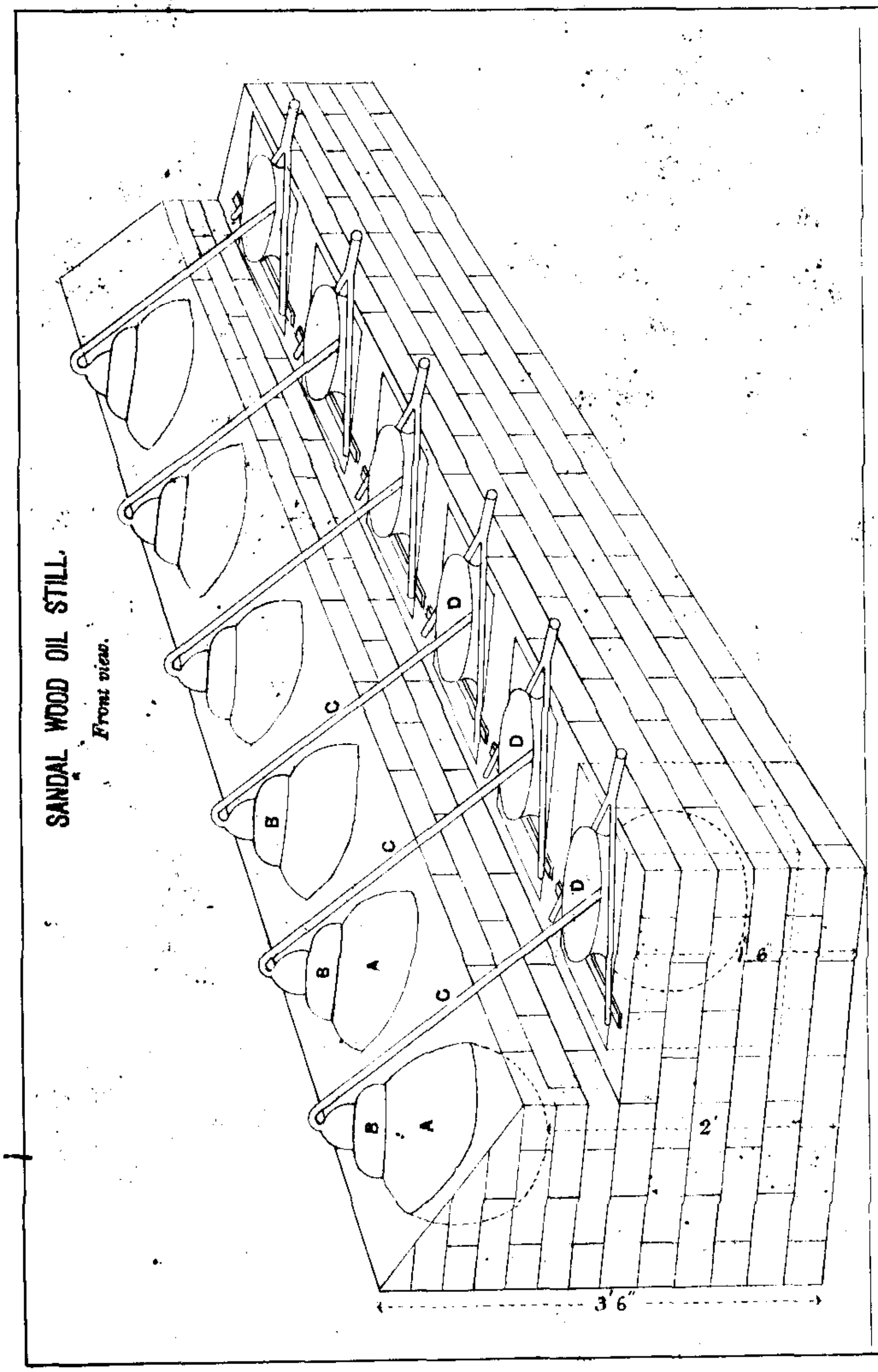
The method of manufacture, which is very rude, and might, doubtless, be greatly improved on, is as follows :—

A site having been selected for the stills, a rough shed is erected as protection against sun and rain, and a bank of mud or sun-dried bricks constructed underneath it. Each shed generally contains 12 stills or furnaces, although only 6 are shown in the sketch (*Plate* I).

The sandal wood (roots preferred) is chipped with a small adze (báji) into small pieces and placed in the large earthen pots (A, A, A) at the top of the bank. Each pot is capable of containing two Madras maunds (56 lbs.) of the chips with the necessary amount of water. On the top of the large pot is a smaller one (B, B, B) fitted tight with clay and cloth, so as to exclude the air, from which runs a copper tube (C, C, C) about 1¼ inches in diameter and about 3 feet 8 inches long, the other end of which is placed in the mouth of an empty copper pot suspended in a large wide mouthed earthen vessel 24 inches in diameter placed in the lower part of the earthen bank. This vessel is kept filled with cold water.

The firing is applied from behind the bank underneath the large earthen pots on upper bank (*see Plate* II.), the steam from

PLATE I.



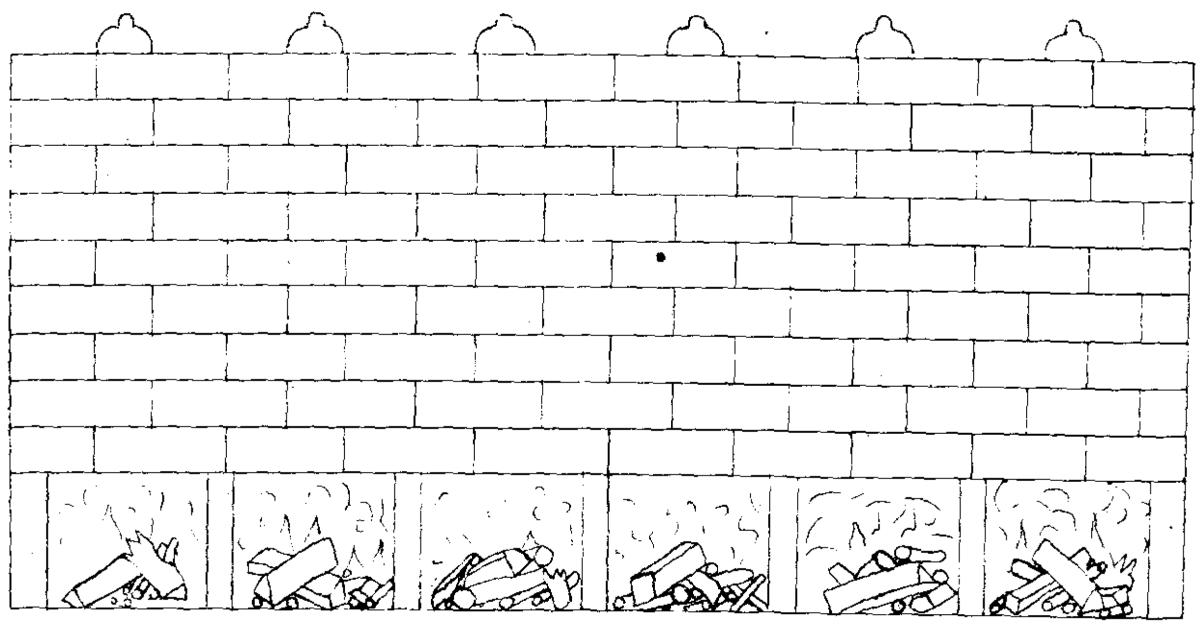
SANDAL WOOD OIL STILL.
Front view.

Litho. T. C. Press, Roorkee.
Thos. D. Bona, Supdt.

PLATE II.

SANDAL WOOD OIL STILL.

Back view.



THOS. D. BONA, Supdt.

which collects in the smaller pot and runs down the copper tube into the copper pot where it is condensed, the cold water surrounding it being renewed as required.

The copper pot (kodapán), which holds about 3 gallons, is supported by a forked piece of wood, which is held in its place by another piece placed transversely across the open earthen receptacle.

The mouths of the copper pots are covered with leaves and coarse grass. As they become filled with water and oil, the latter is skimmed off and emptied into a cistern or shallow tank in the corner of the shed. This is done twice or thrice a day, only a small quantity being obtained each time.

The upper pot holds about 6 gallons of water besides the 56 lbs. of sandal wood chips, which lasts for 21 days, during which the fires are never extinguished.

Immediately one boiling (21 days) is finished, another is commenced.

The working season is supposed to commence on the 1st of August and extend to the 1st of June following, which would be 10 months, but operations rarely commence before the 1st of October, and allowing for holidays, &c., it would not be safe to calculate on a working season of more than 6 months, or nine boilings of 56 lbs. each, representing a consumption of 504 lbs. (18 maunds) per still, or for 1,000 stills, the average number now working, 225 tons of sandal wood per annum.

It is not easy to obtain accurate data as to the outturn of oil per maund or still, but the following is the information given to the District Forest Officer by the Deputy Tahsildar and Haidar Sáhib, the present lessee.

One maund, 28 lbs. of first sort roots produces 2 seers* of oil; 1 maund of second sort, 1½ seers; and of third and fourth sorts from 1¼ to ¾ of a seer.

Haidar Sáhib estimates his average annual outturn per still at 35 seers, 21 lbs. of oil, valued at about Rs. 4-5-0 per seer. Adopting this calculation, the receipts from each still would be Rs. 150-15-0 per annum, or Rs. 1,50,937-8-0 for the 1,000 stills, the total production of oil being 35,000 seers, or 9 tons and 840 lbs.

Most of the oil is, I believe, shipped to Bombay, where it finds a ready market.

As already stated, the sandal wood used in the stills is all obtained from the Mysore plateau above, where the supply of firewood is too limited to admit of manufacture.

The Forest Department in South Canara is, therefore, solely interested in the firewood supply, from which it obtains the revenue, which, when I entered the Department, was credited under sandal wood receipts.

* A seer = 24 rupees weight.

The furnaces are about 3 feet 6 inches long, and from 1 foot square at orifice to 2 feet further back. They are fed by logs of about 6 inches to 12 inches diameter.

Each still is said to consume two head loads or 112 lbs. per day of 24 hours, which is equivalent to one ton per boiling for each still, or a consumption of 9,000 tons of firewood for the 1,000 stills per annum. We receive Rs. 9 per still, and as all the better descriptions of trees, *viz.*, teak, blackwood, sandal, jack, wild jack, ebony, catechu, poon spar, and cinnamon are reserved, and the rate of production in the moist climate of South Canara cannot be less than a ton per acre per annum on a rotation of 10 years, all we have to secure is an area of 90,000 acres, about 140 square miles, within which the sandal wood still operations should be carried on under proper supervision, the system which recommends itself for adoption being that of *coppice with standards.*

The forests along the South Canara ghâts can readily supply such an area, and so far from the operations of the stills doing harm, I believe they may be made productive of much good by affording the means of getting rid of the inferior descriptions of trees, whilst supplying the funds for efficient protection and improvement of the timber forests.

The Mysore and Coorg Forest Departments are also to be congratulated on the presence on their frontier of a ready market for so considerable a quantity of sandal wood roots.

In the present depressed state of the sandal wood market, it appears advisable to do everything in our power to develop and extend the distillation of the oil, for which there is, I believe, an all but unlimited demand, and I trust that this description, and the rough sketches made on the spot, may enable forest officers to initiate experiments in distillation in other districts, where there is ample firewood available (under proper management) in the same forests as contain the sandal wood.

OOTACAMUND :
The 20th April, 1884.

I. CAMPBELL-WALKER.

V. NOTES, QUERIES AND EXTRACTS.

THE CARDAMOM HILLS OF TRAVANCORE.—The night of my arrival at Odumenshola, the elephants were very noisy, and gave us a serenade close to the camp, and another herd about a mile across the valley was evidently troubling the people camped at a Tavalum, or cardamom-collecting station, and tom-toms were beaten and matchlocks fired to drive them off. Our camp was well protected by a deep broad trench, and despite the trumpeting and rumbling growls of the herd, I was able to sleep soundly. A. informed me that elephants often fed close up to the trench, and on one occasion he interviewed a herd with a magnesian light. As long as the light was burning they all stood staring at it (the trench intervening), but on its going out they gave a series of screams, and quickly vanished into the neighbouring jungle. For some nights afterwards they carefully avoided the camp.

I spent several days with A. at Odumenshola, and joined him in his various visits to the neighbouring Tavalum and gardens, as well as on his rounds road making, and I had many opportunities of watching the work of collection and curing the cardamoms. Our ride to a large Tavalum was very interesting as we passed through miles of cardamom forest through which bridle paths had been cut. The Tavalum we visited was some distance beyond the forest, and was a busy scene, as a large amount of cardamoms were being dried on the natural barbacues of rock, and women and children were busy stripping the capsules off the scapes that had just been brought in. From here we rode over a pretty undulating grass country to Callapara, where A. had a large permanent camp for warehousing the cardamoms from the neighbouring forests. This camp as at Odumenshola was surrounded with a trench to keep the elephants out. Previous to the trench being cut, a tusker had, by way of amusement, attacked the bungalow, and despite the efforts of the watchman to drive it away, had damaged a good deal of the verandah before aid came. Near the trench A. pointed out a hill gooseberry or nellikai tree, where a forest tragedy had occurred. The watchman had heard the sound of a sambur, and noticed a large stag steadily facing the grass with his back to the tree as if facing some danger. Presently a tiger sprang on the stag, which received him on his horns, and threw him into the grass, receiving a blow at the same time from the tiger. The stag was seen to lie down, and the watchman going

to see whether it had moved, found it dead. The tiger did not return, and most probably got his death wound, as A., to whom the stag's head was brought, found both brow antlers covered to their bases with blood and tiger's hair. He described the head as the finest he had ever seen. From Callapara we returned to Odumenshola by a pretty bridle path over some miles of open grass country. At a nullah we crossed before rising to the hill on which our camp stood, we disturbed a herd of elephants who from their cleanly appearance had just had a bath in the nullah. Our presence scarcely disturbed them, and they moved off a few yards into a neighbouring bamboo clump, where we could hear them for a long time trampling and crushing the bamboo. A. had some time previously lost a good deal of his baggage here by the attack of a rogue elephant on his coolies. Fortunately for the coolies they had just put down the loads when the tusker rushed among them, and he was too much occupied to notice them crouching in the grass among the cases and packages. Six or seven cases of crockery and provisions were soon smashed up by the rogue, and he would have probably destroyed everything, and hunted the coolies as well but for a case of medicines which disagreed with him and made him beat a retreat. A. came on the scene an hour afterwards and tried to follow him, but he had gone clean off, and his track evidently indicated a great hurry, so A. had to bewail the loss of his goods and chattels without the satisfaction of bringing the rogue to book. Full as the country seemed of elephants (I counted nearly forty in sight at once from our camp) there are many months in the year, I was informed, that they are not to be seen. A. told me they had regular seasons for migrating to the cardamom forests, and that he recognised individuals invariably appearing at the same time every year in what appeared to be well-known runs of theirs. In February they disappeared *en masse* when the hill fires began, and the water was scarce ; to return late in October.

The cultivation of Cardamoms.—I fear I have digressed a great deal from the subject of cardamoms, and must return to my notes. From what I could learn there are two varieties of cardamom in the Travancore forests. One crop comes to maturity about October, and the other in January. The varieties appeared to be caused by difference of rainfall and soil ; the former growing in a misty wet climate and poorer soil than the other, which grows in a comparatively dry climate, and fine rich soil. My small experience was confined to the latter variety. Land having been selected, the Superintendent has to be applied to for leave to open the garden. Nothing is charged in the way of assessment till the garden comes into bearing, when a rate of ten per cent. on the crop is charged for land tax. Only certain forests will grow cardamoms, and the presence of a few wild plants is a safe indication of the suitability of the soil. They will not grow in bamboo or reed jungle, nor

will they thrive under munga-murrum, mella-murrum, or dammer trees. The best aspect is a northern one, and a steep incline is better avoided. The finest gardens I noticed were on easy undulating land, and in such situations I was informed they lasted for years. The opening and preliminary work is very simple. Operations begin in April by the cutting down of all undergrowth to 6 or 8 inches in diameter; and here and there large trees of rapid growth are cut down. No burning is done as in coffee clearings, and the felled branches and undergrowth are allowed to rot. In the following October the young cardamoms begin to sprout. Where they are too crowded, it is necessary to thin them out and transplant them into the open spaces, and where the plants have sparely sprouted, it is also usual to sow the ground with seed. The seed should be sown before the monsoon. The growers prefer stocking their gardens with spontaneously grown plants, which they say last longer and come late, bearing earlier than those grown from seed. For two years nothing further is done. In the third year the clearing should be weeded, and the small sprinkling of crop gathered. In the fourth year a thorough weeding ought to be done, and the decayed stalks and leaves heaped up between the clump of cardamoms. The garden is now in full bearing, and will require regular attention. The weeding should be done in November, and the crop comes immediately to maturity with the letting in of light and air. Cardamoms require light showery weather in March and April, when the flowering scapes are ready to blossom. In rich soil the scapes will run out to 3 and 4 feet in length, but shorter growths give better results in the way of crop. The failure of showery weather immediately after the blossom will ruin the prospects of the crop, and though the scapes will sometimes throw out a second blossom, the result is generally a poor one. The fluctuations of crop are therefore great, and as hail storms often occur about the blossoming time, the risk and uncertainty of crop is much increased. Cardamoms begin to ripen in November, but it is often late in January before the growers will pick the crop, and a great deal is destroyed by snakes, rats and vermin of every description. Judging from what I saw in the garden, of capsule shells, probably one-third is lost in this way. Chetties from the neighbouring villages in the Madura District, are the principal growers, and they usually begin the cardamom harvest when about half the remaining capsules on the scapes are ripe.

The scapes with the cardamoms on are removed to the small collecting stations, and cured by a process of drying in the sun and exposure to the dew. The morning after the collection the capsules are carefully removed from the scapes, and dried on the rocks. The fleshy shell soon loses its green or brown colour under the three or four days drying, and is then fit to be removed to the weighing stations. Cardamoms lose two-thirds,

three-quarters, or even four-fifths of their measure by drying; the exposure to dew is supposed to give a bleached look to the sample. Some cardamoms I noticed had a green tinge which no amount of drying could remove, and was supposed to be caused by the nature of the soil they came from. Could the crop be gathered in, as it ripened, there is no doubt a much better sample could be secured, but I was informed that it would not pay the growers to do this, as the Travancore Government made no distinction in the price for bad or good qualities, and the result was the loss of much of the ripe fruit and the character of the rest being damaged by indiscriminate packing of mature and unripe capsules together. A second curing and winnowing is given at the weighing stations, and there is a further drying and winnowing on the coast when the cardamoms are ready for the buyer. On the coast the best descriptions will realize as much as Rs. 4 per lb. *(Dutch), but the grower only* receives a third of this, and when all deductions from this third are made for watchmen, land tax and other petty charges, the amount really paid is nearer one-fourth than one-third. From notes taken of the cost of cultivation, I was doubtful whether the growers could make any thing by the transaction, but the fact of their continuing to cultivate is proof that they do make something. A. considered it paid the growers if they secured two good crops to three bad ones; but he admitted that it was very difficult in bad seasons to get the owners to take in their crops, and he had often to do so at the Government's expense. At one time the produce had been as high as 3,000 cwt., but had subsequently dwindled down to a tenth of that quantity. Since A's incumbency more land has been opened up and abandoned gardens brought into cultivation, and he had lately a crop of 1,500 cwt. A more liberal policy on the part of the Travancore authorities would soon double the cultivation. Nearly all the cardamom growers are British subjects, owing no doubt to the fact that the forests as far as the Pereyaur had once been under British jurisdiction. About the second decade of this century, this tract was transferred to the Travancore Government, and the cultivators who were British subjects continued their occupation under the new rule. Roughly estimated about 20,000 acres were under cultivation, and from what I could learn there was forest land enough available for extending the cultivation five fold. The yield per acre in even favourable time does not exceed 20 to 25 lbs. of cardamoms.

In addition to cardamoms the Travancore Government collect ivory, wax, gallnuts and other hill products, and obtain some revenue from teak and blackwood, and also from cattle grazing fees. Altogether the average nett revenue comes to about 2 lakhs of rupees. No land is granted for otherwise than cardamom cultivation—a wise policy on the part of the Travancore Government, as without losing their forests they obtain a safe

though fluctuating revenue. Still there is a good deal of land suitable for grain cultivation which is not allowed to be cultivated though ready with a light tickling of the surface to yield fine crops. The wandering hill tribes in return for Sircar service are alone allowed to grow any grain, and they are restricted to old nursery clearings.

Though the cardamom hills are unoccupied at present by any resident population, there was a time when they must have been inhabited, as ruins of forts, rude carvings, and inscriptions plentifully testify, but there are no traditions of the old inhabitants, and the present hill tribes, according to their own account, are but comparatively recent settlers. The present hill men are of either Tamil or Malayalam origin, and seem to have settled on the hills in the last three hundred years. They are fine men in physique though living in feverish places, and *according to census returns are on the increase.* The Railway has made the country accessible, as twenty-four hours from the Railway Station of Ammanackenoor would land the sportsmen at some of the finest shikar grounds in Southern India.—*Madras Mail.*

REARING SILKWORMS IN THE CHANGA MANGA PLANTATION.—A correspondent sends some interesting information to the Lahore paper on the rearing of silkworms in the Changa Manga Plantation. He says:—

"Changa Manga is a sissú plantation of 11,000 acres, situated 44 miles from Lahore on the Mooltan Railway line. During the last few years a thick undergrowth of mulberry has sprung up under the shade of the sissú. This is due most probably to the immense number of starlings and other birds that visit the plantation during the time the mulberries are ripe. This undergrowth is encouraged by the Forest officers, in order to cover the ground from the hot rays of the sun during the summer, and to keep down the dense growth of coarse *kana* grass, which springs up during the rainy season. There are now several hundred acres of this mulberry undergrowth; and Mr. Ribbentrop, Conservator of Forests, suggested that it might be utilized in rearing silkworms. Mr. Lemarchand, Deputy Conservator of Forests, was accordingly deputed to the Gurdaspur district to collect all the information necessary on the subject, and to start the scheme at once. Twelve chittacks (24 oz.) of Japan eggs were obtained from Mr. Keighly, of Madhopur, in February last. During March the worms began to appear; and now they cover a space of nearly 1,300 square feet, packed close together. There are at present four rearing sheds covering an area of 2,000 square feet. This is insufficient, and more sheds are being built. So far, the experiment has proved a great success; and it is well worth any one's while to run down from Lahore to see what is being done; Changa Manga is only a two hours' run from Lahore, and it is the largest sissú plantation in India, besides being the prettiest spot in the district."

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The Forestry Department in the Punjab is thus bestirring itself in the growth of the mulberry plant, an undergrowth of which is said to extend over an area of 12,000 acres of sissú plantation on the Lahore and Mooltan railway, and to utilise these, an abundant supply of the best variety of silkworm eggs has been procured, large breeding sheds have been erected, and there is every prospect of an extensive industry growing up. Let the Punjab authorities however, remember that to rear the worms and obtain a supply of cocoons are not sufficient to ensure the complete success of this industry. Great care and attention must be given to the winding-off the silk, for if this be done carelessly all previous labor will have been in vain. It is in this that the natives of Bengal have so completely failed, to the depreciation of Bengal silk and the decay of the trade in the article ; and it was this same negligence and indifference to their own interests which ruined the hand-loom industry in jute 30 years ago, and compelled the shippers of gunny cloth and bags to introduce machinery for spinning and weaving, in substitution of hand labor.—*Indian Agriculturist.*

Guinea-Grass and Lucerne.—The following is from the Proceedings of the Agri-Horticultural Society of India, and we are very much obliged to the Secretary, Mr. Blechynden, for his corrections to our correspondent's paper :—

An article under the above heading, appeared in the correspondence columns of the "Indian Forester" for March, in which it is stated that guinea-grass was "introduced into India apparently not much earlier than 1870, in which year it was cultivated at the Madras Experimental Farm." On reference to the Society's Journal it will be found that the introduction of guinea-grass into India attracted the attention of the Society in 1836, some 34 years before its cultivation at the Madras Farm ; and in the correspondence which ensued Mr. John Bell, the then Secretary, mentions that he had cultivated the grass with success in 1831, and subsequent years. In 1837, four prizes were offered by the Society, ranging from Rs. 200 and a gold medal, for the best guinea-grass cultivation of 20 bigahs, to Rs. 50 for 20 seers of guinea-grass seed. In 1838, mention is made of the grass succeeding in Azimgarh, Hissar, Cawnpore, Beawur and Coel, wherever the last named two places may be, about two maunds of seed having been distributed in that year. In 1848 a curious paper on the cultivation of guinea-grass was forwarded to the Society, and will be found in Vol. VI., it was apparently published in Calcutta originally, in 1793, dedicated to Sir William Jones. The directions given are clear and concise.

The following rules for silos are taken from the "Englishman"

in a paper on the recent very successful experiments in Calcutta :—

1st.—The sides of silos must be as nearly perpendicular as possible.

2nd.—The grass, &c., should be well spread and heavily trampled as it is being filled into the silo.

3rd.—The weight on the top of the silo must be at least equal to 200 lbs. to the square foot, which is given by 2 feet of earth or bricks ; and the more imperfect the silo, the more pressure it requires.

4th.—And most important of all, the layer of earth immediately over the top of the ensilage must be made as air-tight as possible, by simply working the surface of it into mud and plastering this down. The primary layer need not be more than four or five inches thick : if earth is difficult to get, the remainder of the weight necessary may be made up with anything that is dry.

A silo may be filled with any number of different kinds of green forage, and this may be leisurely done in two or three days, but the quicker it is done the greener and fresher will be the ensilage. In opening a silo for use, remove as little of the weight as possible, as the pressure prevents the air from penetrating far into the mass.

CASHAW (*Prosopis juliflora*).—The following extract from the last report of the Agricultural Horticultural Society of India is interesting :—

A parcel of this seed has been received from Mr. D. Morris, Director, Botanical Department, Jamaica, as well as seeds of *Gouania domingensis*, *Cassia Fistula*, *Calyptronoma Swarzia*, *Cassia obovata* :—

Mr. Morris writes as follows :—

"I beg to forward herewith seed of *Prosopis juliflora*, known here as 'Cashaw,' which is an admirable tree (often attaining a height of 40 to 60 feet) to grow in dry gravelly soil, and in situations where rain does not fall for months together.

"It is fast growing : the timber is excessively hard and of a remarkably durable character. It is used for making knees of boats and all work requiring strength and tenacity. Posts of 'Cashaw' in wire fences last longer than any other, and are in great request for that purpose. Kingston is supplied annually with hundreds of tons of Cashaw, which is the only firewood immediately accessible.

"The pods are of a sweetish succulent character eagerly sought for by cattle : indeed in some parts of this island during droughts they subsist largely on them. For horses and mules the pods are also admirable food, but I would add that in their case it is very undesirable to allow them to feed upon the pods immediately after they have been exposed to rain, as ill effects have been

known to arise from the partially germinated seeds being taken into the stomach, causing great pain and not unfrequently death; this last occurence, however, is so rare that it need not enter into the calculations of the planter. The tree fruits during dry weather when there is little probability of rain, and if the pods are collected and stored in a dry place they will be ready at hand in a sound state for all forage purposes. When thus stored, the pods, instead of being given whole are often broken up or ground, when they answer admirably instead of corn, oats, &c."

THE common Forest Trees of the Adirondacks are the American linden or basswood, sugar maple, black sugar maple, red or swamp maple, black cherry, beech, ironwood, cherry birch, yellow birch, paper or canoe birch, American aspen, large-toothed aspen, white pine, red pine, black spruce, white spruce, hemlock, balsam, fir, larch, white cedar. The above are more or less common. The following are rare, or occur only along the borders of the wilderness: locust, white ash, black ash, elm, slippery elm, butternut, swamp hickory, three species of oaks, balsam poplar, pitch pine, and juniper. As the Adirondack forests are attracting considerable attention at present, says the *Lumber World*, an enumeration of their trees is not perhaps out of place.—*Timber Trades Journal.*

MATCHES.*—IT would more than repay a day's sojourn at Jonkoping, says the *Pall Mall Gazette*, to visit the factory whence proceeds not a small part of the light of the world. The latest novelty, only at work for about a month, is an enormous engine, which daily produces 1,000,000 boxes of Swedish matches. This wonderful machine receives the raw material, namely, blocks of wood, at one end, and, after a while, gives up at the other the matches neatly arranged in their boxes, ready to be despatched to the uttermost ends of the world. The wood which in the course of last summer was brought over to Jonkoping to be made into matches filled twenty steamers and eight sailing vessels.—*Timber Trades Journal.*

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* Cannot some attempt be made to start a match manufactory in India, where so much refuse wood is available, as in our Hill Forests.—[ED.]

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RETIREMENT OF COLONEL PEARSON.

WE translate as follows from the March Number of the "Revue des Eaux et Forêts."

"By a resolution of the Minister of Agriculture, dated the 9th of February, 1884, Colonel Pearson attached to the Forest School, Nancy, by the British Government, has been made 'Chevalier du Mérite agricole.' All foresters who know this worthy officer will approve of the honor conferred on him, earned by numerous services rendered both to forest administration in India, and to the Forest School. Colonel Pearson, who has been attached to the School since 1873, is about to retire, and will leave Nancy in the course of the year.

"He will carry with him to his own country the esteem and affection of all French foresters."

Colonel Pearson has been succeeded by Major Bailey probably till September 1886, after which date the connection between Nancy and the Indian Forest Department will be broken up, at any rate the Forest Students appointed at home, will no longer regularly attend the course at the Nancy Forest School, though they may still be deputed to France for a few months to study forestry.

Colonel Pearson, who has now permanently retired from Government service, was appointed Superintendent of Forests, Central Provinces, on the 21st September, 1860, and Conservator of Forests there on the 1st May, 1864. He was then transferred to the North-West Provinces as Conservator in September 1868, and held that appointment till 29th January, 1871, becoming officiating Inspector General of Forests till December 1872, when he proceeded home on furlough. He took charge of the English students at Nancy in 1874, and has held the appointment of Director of Forest studies at Nancy till relieved by Major Bailey last March. His kind disposition and genial manners have made him a general favorite with all Nancy men.

NOTES ON INTRODUCED TREES IN CAPE COLONY.

(*Continued from page* 111.)

AT Worcester, 7 hours by rail from Cape Town, on the Cape Town and Diamond Field Railway, there is a flourishing Government plantation of Eucalypts—mostly blue-gums. The rainfall here is only 12 inches (mean of seven years 11·62 inches) per annum, but the plantation is irrigated, water being turned on seven or eight times in the course of the year. Worcester is 776 feet above the sea, and has a mean temperature of about 63° Fah. A sample-area of a third of an acre in the plantation, measured as were the sample-areas in the Nilgiri plantations, gave the following results :—

Acre-increment,... ... ... 11·77 tons.
Individual-increment, ... 0·7785 cubic feet.

The appearance of the plantation leaves little to be desired.

Besides *Eucalyptus globulus*, there has been planted recently a good deal of *Eucalyptus robusta*, which there flourishes in all the beauty of its rich foliage and sturdy stems. If anything, the growth of *Eucalyptus robusta* at Worcester surpasses that of the blue-gum. The following table shows the growth in the sample-area taken across the oldest planting which is exclusively of *Eucalyptus globulus*.

Measurement of rate of growth of Blue-gums at Worcester plantation, Cape Colony.

Number of Tree.	Girth at 5 feet.	Height of Tree.	Ideal cylinder.	Number of Tree.	Girth at 5 feet.	Height of Tree.	Ideal cylinder.
1	2	3	4	1	2	3	4
1	16	34	4·81	16	19	45	8·97
2	21	46	11·21	17	20	55	12·15
3	21	46	10·96	18	20	47	10·38
4	13	30	2·80	19	23	54	15·78
5	22	51	13·64	20	17	45	7·18
6	7	20	·54	21	12	32	2·54
7	21	49	11·94	22	13	39	3·64
8	15	39	4·84	23	23	59	17·24
9	18	15	8·05	24	18	54	9·66
10	22	51	13·64	25	11	34	2·27
11	15	46	5·71	26	20	56	12·37
12	9	30	1·34	27	16	42	5·94
13	21	49	11·94	28	22	59	15·78
14	19	39	7·78	29	24	61	19·41
15	26	53	19·79	30	30	65	32·32
			128·99				175·63

Number of Tree.	Girth at 5 feet.	Height of Tree.	Ideal cylinder.	Number of Tree.	Girth at 5 feet.	Height of Tree.	Ideal cylinder.
1	2	3	4	1	2	3	4
31	15	35	4·35	74	22	61	16·31
32	13	40	3·73	75	20	65	14·36
33	33	70	42·12	76	21	67	16·32
34	26	48	17·93	77	19	62	12·36
35	8	26	·91	78	18	60	10·74
36	24	59	18·78	79	21	70	17·05
37	28	65	28·16	80	14	50	5·41
38	23	71	20·75	81	17	44	7·02
39	17	56	8·94	82	19	42	8·37
40	22	57	15·24	83	18	45	8·05
41	19	65	12·96	84	20	60	13·26
42	19	68	13.56	85	14	36	3·89
43	25	63	21·75	86	14	45	4·87
44	12	36	2·86	87	22	60	16·04
45	11	26	1·73	88	19	57	11·37
46	25	52	17·96	89	23	70	20·46
47	28	70	30·32	90	14	46	4·98
48	16	58	8·20	91	18	59	10·56
49	22	57	15·24	92	19	56	11·17
50	12	37	2·94	93	12	40	3·18
51	19	58	11·57	94	18	61	10·92
52	18	56	10·02	95	27	65	26·18
53	16	45	6·36	96	24	60	19·09
54	13	35	3·26	97	16	39	5·51
55	8	31	1·09	98	15	43	5·34
56	9	36	1·61	99	18	46	8·23
57	12	40	3·18	100	20	58	12·82
58	20	59	13·04	101	20	57	12·59
59	12	36	2·86	102	22	63	16·85
60	14	46	4·98	103	12	40	3·18
61	23	57	16·66	104	21	58	14·13
62	22	44	11·76	105	14	50	5·41
63	30	76	37·79	106	18	60	10.74
64	19	58	11·57	107	21	68	16·57
65	15	44	5·47	108	15	50	6·21
66	23	59	17·24	109	19	64	12·76
67	22	58	15·51	110	19	50	9·97
68	19	52	10·37	111	10	34	1·87
69	18	50	8·95	112	29	60	27·88
70	23	60	17·54	113	14	36	3·89
71	10	34	1·87	114	21	52	12·67
72	19	55	10·97	115	22	60	16·04
73	12	34	2·70	116	16	50	7·07
			514·80				481·69

Number of Tree.	Girth at 5 feet.	Height of Tree.	Ideal cylinder.	Number of Tree.	Girth at 5 feet.	Height of Tree.	Ideal cylinder.
1	2	3	4	1	2	3	4
117	23	64	18·70	160	11	34	2·27
118	20	55	12·15	161	24	60	19·09
119	21	60	14·62	162	19	60	11·96
120	22	62	16·58	163	20	54	11·93
121	22	68	18·18	164	19	55	10·97
122	10	30	1·65	165	20	60	13·26
123	10	30	1·65	166	15	50	6·21
124	24	68	21·64	167	18	50	8·95
125	13	40	3·73	168	19	52	10·37
126	15	42	5·22	169	22	48	12·83
127	18	50	8·95	170	19	60	11·96
128	15	30	3·73	171	12	28	2·22
129	27	56	22·56	172	24	60	19·09
130	25	61	21·06	173	19	40	7·97
131	15	50	6·21	174	22	64	17·11
132	23	66	19·29	175	19	60	11·96
133	21	60	14·62	176	17	58	9·26
134	22	74	19·79	177	22	52	13·90
135	26	74	27·64	178	17	50	7·98
136	8	30	1·06	179	24	70	22·28
137	12	34	2·70	180	17	58	9·26
138	25	66	22·79	181	18	43	7·69
139	24	60	19·09	182	31	64	33·98
140	22	49	13·10	183	24	60	19·09
141	22	63	16·85	184	18	50	8·95
142	17	47	7·50	185	20	46	10·16
143	21	60	14·62	186	21	43	10·47
144	15	58	7·21	187	22	53	14·17
145	22	60	16·04	188	18	50	3·22
146	24	60	19·09	189	19	50	9·97
147	7	30	·81	190	16	42	5·94
148	13	56	5·23	191	30	68	33·82
149	21	65	15·84	192	10	30	1·65
150	8	30	1·06	193	21	50	12·18
151	16	45	6·36	194	11	31	2·07
152	21	64	15·59	195	20	60	13·26
153	24	66	21·00	196	21	54	13·16
154	9	32	1·43	197	7	24	0·64
155	27	61	24·57	198	9	34	1·52
156	9	30	1·34	199	23	42	12·27
157	19	58	11·57	200	18	42	7·52
158	14	54	5·85	201	28	60	25·99
159	18	54	9·66	202	19	38	7·58
			518·33				496·13

Number of Tree.	Girth at 5 feet.	Height of Tree.	Ideal cylinder.	Number of Tree.	Girth at 5 feet.	Height of Tree.	Ideal cylinder.
1	2	3	4	1	2	3	4
203	16	45	6·36	219	9	34	1·52
204	27	60	24·17	220	19	60	11·96
205	24	68	21·64	221	24	66	21·00
206	14	40	4·33	222	25	64	22·10
207	23	65	19·00	223	27	54	21·75
208	19	62	12·36	224	18	56	10·02
209	35	74	50·09	225	9	30	1·34
210	34	55	35·13	226	25	62	21·41
211	18	57	10·20	227	11	36	2·40
212	27	58	23·36	228	9	33	1·47
213	26	70	26·15	229	18	60	10·74
214	11	30	2·00	230	21	61	14·86
215	22	65	17·38	231	22	61	16·31
216	21	50	12·18	232	23	64	18·70
217	29	74	34·39				175·58
218	24	63	20·05				
			318·79	Grand Total, cubic feet,			2809·94

Calculation of Results.—The form-factor here used (0·45) was calculated from similar blue-gum plantations in India.

Applying this figure to the above measurements of trees, we obtain—

Total stock on sample-area = 2809·94 × 0·45 = 1264·47 cubic feet, or stock per acre = 1264·47 cubic feet ÷ $0{\cdot}33\dot{3}$ acres (the area of the sample-area) = 3793·41 cubic feet.

The total number of trees on the sample-area is 232.

" " " per acre is 696.

Thus the actual stock on the ground per acre is 3793·41 cubic feet in 696 trees, and the cubic content of an average tree is 5·45 cubic feet.

Figures of Growth.—The yearly individual-increment is the figure representing the average growth of an average tree in a plantation, during a term of years; thus at Worcester the yearly individual-increment = 5·45 ÷ 7 (the age of the plantation) = 0·7785 cubic feet.

2. The acre-increment, a more important figure, is the average yearly yield of an average acre of fully stocked planting, over a term of years. It is the figure of growth (so many tons of dry wood per acre) which represents the actual economic value of the plantation. In calculating the acre-increment, blanks in the canopy, and thinnings, must be allowed for. Blanks in the canopy, from whatever cause produced, are, as long as they last, simply losses of productive area. Thinnings represent the realized yield, or what is sometimes called the "crop," up to date.

In the Worcester plantation the blanks are estimated at 50·25 average trees = 150·75 per acre. An average tree cubing 5·45 cubic feet, the blanks per acre are thus estimated at 150·75 × 5·45 = 821·59 cubic feet. The plantation being very young there have been no thinnings.

Thus at Worcester the acre-increment is—

$$\frac{\text{Actual stock} + \text{blanks} + \text{thinnings}}{\text{present age}} = \frac{3793{\cdot}41 + 821{\cdot}59 + 0{\cdot}0}{7} = 659{\cdot}29$$

cubic feet, or (at 56 cubic feet per ton) 11·77 tons.

The following table (p. 301) exhibits the comparison between the Worcester plantation and two blue-gum plantations of similar growth and density on the Nilgiri mountains in Southern India. Worcester has a rainfall of only 12 inches, but the plantation is irrigated, water being turned on seven or eight times in the course of the year. The Indian plantations have a rainfall of about 40 inches. Otherwise the climate is similar, the Indian plantations having a lower mean air temperature, but a hotter sun than the Worcester plantation.

The Eucalypt-like *Tristania conferta* which I tried in vain to raise in Mysore, I have noticed as a handsome free-growing tree in several localities in Cape Colony.

The Indian *Melia Azaderach* or Persian Lilac, is frequently met with planted near houses in Cape Colony, and oddly enough the colonial name for this tree is Seringa.

In some parts of the Colony poplars have been extensively planted. A species at Wynberg, apparently *Populus alba*, grows like a weed, and overruns pieces of waste ground like *Acacia dealbata* on the Nilgiris.

The common weeping willow *Salix babylonica* is frequently noticeable, planted near streams and water dams on farms. And in some of the old Dutch towns it has been planted with the prettiest effect at the edge of the watercourses which run down the side of each street. It becomes quite leafless in winter, and its sweet waving spring foliage seems to appear a week or two after that of the oak. The weeping willow is of course a type of beauty in itself, but those old Dutch tree-planters knew what they were about when they placed the oak and willow side by side, the massive glory of the one contrasting with the tender grace of the other.

I have noticed the common alder, *Almus glutinosa* growing by the side of a river, and looking exactly as it does in Europe: it is apparently the naturalized European tree, but why or when introduced, I know not. Dr. Harvey observes—"The common alder (*Almus glutinosa*) is found throughout the Colony, apparently wild, but whether truly so, or not, I cannot say." Possibly the alder may have been introduced in the old fighting days, and planted as it is in Europe, for the sake of its charcoal, which is prized in making gunpowder.

Comparative Table of Acre-increments of Blue-Gum plantations.

Plantations.		Area of plantation, in acres.	Age of sample-area, in years.	Elevation, in feet.	Area of sample-area, in acres.	Number of trees per acre now on the ground.	Form-factor used.	Actual stock now on the ground per acre, cubic feet.	Yearly individual-increment (actual), cubic feet.	Yearly acre-increment (calculated), *tons of dry wood.	Detail of Acre-increment. From standing stock, tons dry wood.	Detail of Acre-increment. From blanks in canopy, tons dry wood.	Detail of Acre-increment. From previous thinnings, tons dry wood.
Eucalyptus globulus, or Blue-gum.													
Bathri, ...	India.	60	5	7,235	1·708	847·19	0·4717	2,966	0·70021	13·067	10·593	2·474	0·00
Norwood, ...	India.	26	10	7,550	1·221	416·00	0·447	6,829	1·64171	13·434	12·196	0·263	0·975
Ralia, ...	India.	60	10	7,215	0·269	523·19	0·45	6,960	1·33025	12·428	12·428	...	0·00
Worcester, ...		...	7	776	0·333	696·00	0·45	3,793	0·7785	11·773	9·677	2·096	0·00

* For blue-gum, one ton of dry young wood with bark = 56 cubic feet.

There is in Cape Colony a variety of conifers which appear to be successful introductions, but have not been planted on a sufficiently large scale to test their naturalization. Of the three common European pines, *Pinus sylvestris*, *Pinus Pinaster*, and *Pinus Pinea*, the first, it has been seen, has not succeeded, while the two latter have become completely naturalized in Cape Colony. Introduced nearly 200 years ago, they are probably one of the most perfect examples of naturalization in the Southern hemisphere. *Pinus Pinaster* in Cape Colony need now hardly fear the fate which has overtaken it on the coast of Gascony, where the exceptional frost of two years ago wrought such terrible havoc on the sand-drift plantations. But *Pinus sylvestris* is so essentially a cold-loving species, extending, it is stated, to as high a latitude as 74° north, that it could hardly be expected to naturalize in a country just outside the southern tropic. A few Scotch firs are however now being tried by the Forest Department on the Eastern mountains of the Colony, at an elevation of 4,500 feet.

Pinus halepensis is of comparatively recent introduction: it appears to succeed well wherever planted. Count de Vasselot, the head of the Cape Forest Department, is in favour of the extended planting of this tree. In the Port Elizabeth botanic gardens I saw a healthy specimen of *Pinus halepensis* growing side by side with an equally promising *Pinus insignis*. In Cape Colony *Pinus halepensis* seems to be a good pine for hot dry situations, indeed it appears to grow better in the Port Elizabeth gardens and park, than the naturalized *Pinus Pinaster*. In the same gardens was the curiosity of a banyan and a Moreton bay fig growing side by side. Of these two it must be confessed that the Australian fig presented a better appearance than the Indian—of roadside memory!

Pinus insignis succeeds admirably as a garden tree, showing something of the fine growth which characterises this species on the Nilgiris; and in one locality it has been planted successfully on a large scale—at Grahamstown above the botanic gardens. While speaking of Grahamstown, let me introduce Mr. Tidmarsh and his gardens to Indian Foresters. Mr. Tidmarsh has for some years raised plants from seed sent him by the Indian Forest Department, and his gardens, the best in the Colony, would well repay a visit should any member of the Indian Forest service find his way to a corner of the world, formerly so near to, and now so far from, India. I had the pleasure of seeing quite a collection of young trees which "came from Dr. Brandis." There was deodar, raised in quantity, and with some fair specimens planted out in the gardens, but deodar seems to demand more moisture to grow well. Its right place is evidently in the Amatolas and other mountainous regions of the Colony. Generally speaking Himalayan Abies and pines show a very slow growth in the dry climate of Grahamstown,

and the same remark applies to the Californian conifers. *Taxodium distichum* and *Juniperus barbadensis*, which succeed in the damper climate of Cape Town, seem failures at Grahamstown; but on the other hand *Pinus tuberculata*, *Cupressus macrocarpa* and *Cupressus torulosa*, which showed a good growth in the wet climate of Ootacamund, seem equally at home at Grahamstown. In the Port Elizabeth gardens and park, both *Cupressus macrocarpa* and *Cupressus torulosa* grow well, but the latter seems to suffer from the wind in that exposed situation. At that place also are some trees of *Schinus mole* raised from seed brought direct from California. This singularly graceful tree has been planted for some years at Bangalore, but it was not known there from whence introduced. At Bangalore it grows freely, but does not yield fertile seed.

Quercus Suber appears to succeed on dry situations in Cape Colony, and is well worth planting on an extended scale. *Quercus Ilex*, the Holm oak so extensively planted in the grounds round Italian palaces, I have looked for in vain in Cape Colony. Its dark evergreen foliage is richly beautiful in the mellow light of an Italian winter sun; but in Cape Colony, where most of the indigenous trees are evergreen, it would not have the same *raison d'être*. Neither has one in South Africa quite the low sun necessary for the best lighting up of foliage, nor, let us add—the palaces.

The Holm oak in Italy recalls the olive. Every one has read of the olive tree culture of Italy; the olive plantations there look like natural woods. But perhaps the most curious sight is that of some of the old veteran trees, standing alone in the fields, perhaps whispering tales of the Roman Emperors, in their still vigorous leafage, their aged limbs supported on rough pillars of masonry.

There are four indigenous species of *Olea* in South Africa. *Olea verrucosa*, called the wild olive in Cape Colony, is very like the common European olive. It has a wide distribution in South Africa, extending from the Coast to some distance across the tropic on the highlands of the interior. The various varieties of the cultivated European olive can be grafted on the African wild olive, or can be raised easily from cuttings, as has been done for some years in the Cape Town botanical gardens. In fact, in Cape Colony, olive culture is a proved cultural success, exactly as in Australia, it is a success both culturally and financially. The European varieties of olive in the Cape Town botanical gardens, though in a bad situation and on poor soil, are now yielding good fruit. In Australia olive growing is fast becoming an established industry: yet in Cape Colony there are no olive plantations. The slowness of the return is probably partly the cause of this. Professor McOwan of the Cape Town botanical gardens, mentioned 17 years as about the time that must elapse before an olive planter could hope to reap any

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appreciable return, and in a new country where money is scarce and people look for quick returns, this is doubtless a serious objection. But for him who can afford to wait, olive culture in Cape Colony offers no uncertain road to a competency; and how many men are there not now in India, who after 17 years in tea or coffee have achieved nothing more than a broken constitution? And in Cape Colony how many agriculturists are there not, who after struggling for years with the uncertain rainfall, have eventually abandoned the plough, poorer men than when they broke their first sod. The Cape climate is in general a hazardous one for agriculture, but on the whole is favorable to arboriculture, and tree planting would ordinarily be free from the risk from drought attending the culture of cereals.

Three species of Casuarina have been planted; two to some extent in Cape Town and the older portion of the Colony: the third species a recent and promising introduction. One of the old Cape Town species has been quite wrongly referred to as *Casuarina equisetifolia*, the well known Indian species, of which such fine plantations have been made on the Madras Coast, and on the Mysore plateau. The naturalized Cape species, which is also called "Filao," from the Mauritian name, is possibly *Casuarina muricata*. The second naturalized Cape Casuarina has been called *Casuarina tenuissima*. I have not had an opportunity of comparing either of these species with a published description. They are both poor bushy looking trees, very inferior to *Casuarina equisetifolia* in Southern India. The recently introduced species, *Casuarina leptoclada*, is as yet hardly to be met with outside botanical gardens. But it is a most promising introduction, resembling in its regular tree-like form, the tropical *Casuarina equisetifolia*; it grows fast and seeds freely. Comparing it to the common Indian species, the jointed leaf-like stems are longer and more drooping, the cone considerably larger and more globular.

Grevillea robusta, which flourishes as a planted tree in South India from 2,000 feet to 7,000 feet elevation, grows well throughout Cape Colony, but not with the same foliage and luxuriance as in India. Its manner of flowering too is different in the two countries. In India, the tree yields fertile seed, but the blossom is comparatively scanty. In Cape Colony, the tree when in blossom, presents quite a showy spectacle, the upper portion of the crown becoming a mass of golden flower, nearly equal in appearance to that of the *Poinciana regia* in flower. *Grevillea robusta* yields fertile seed, and is evidently naturalized in South Africa, but whether more at home in South Africa than in India I am unable to say, not having seen the tree in Australia. There is no doubt about the identity of the common species here and in India.

The Australian Acacias.—Acacia Melanoxylon, the Australian

blackwood, is popular, somewhat beyond its merits, in Cape Colony. From west to east it has been very extensively planted as an ornamental tree. But in the west quite a raid has been made recently on the blackwoods, on account of their liability to become infested with Dorethesia. A few months ago I visited a town lying in a scorched plain bounded by clear cut mountains, which a few years ago was described as being beautifully shaded by blackwoods. These had been all cut down by the Municipality, and gums planted in their stead. After the fashion of Dutch towns, there was water flowing down the sides of the streets, of which the trees got the benefit. Without irrigation the *Acacia Melanoxylon* in Cape Colony has a meagre starved appearance. This is very apparent to any one who can remember the fine tree of the Nilgiris, its massive umbrageous foliage flecked as with snow, when the mild weather after the south-west monsoon sets in. On the Nilgiris the planting of *Acacia Melanoxylon* on a large scale has had to be abandoned on account of the attacks of a species of Loranth, to which the tree is subject. In Cape Colony it falls a prey to the Dorethesia, and is being cut down sometimes wholesale, as in the instance given above. As on the Nilgiris it is here a free seeder but a poor coppicer.

The Australian wattles seem to grow with ease at the Cape. Plantations of *Acacia pycnantha* and *A. decurrens* have been formed near Cape Town, with every chance of large profits for tanning purposes. Perhaps *Acacia glaucophylla* is the species which has been most planted. *Acacia dealbata* grows, but not with that troublesome luxuriance which has caused as much as Rs. 30 an acre to be paid at Ootacamund for its extirpation near houses. I witnessed a few days ago a very successful case of sand drift fixing at East London by the planting of the Acacia, known as Port Jackson willow. Mr. Tidmarsh informs me that under the Colonial name of Port Jackson willow are comprised two species—*Acacia homalophylla* and *Acacia sophoræ*: both species are extensively planted as hedges and break-winds. Near Cape Point, Port Jackson willow is the only tree vegetation that can withstand the fierce tempests of the Cape of storms. It is mainly with *Acacia glaucophylla* that the Cape flats have been planted—a neck of shifting sand which joins the Cape peninsula to the mainland.

I have spoken of olives, and it remains to add a few words about fruit trees, though these have a lessened interest to Foresters, and it is time to bring these notes to a close.

The cherry and walnut, yielding both wood and fruit, must be mentioned. Both of these succeed best in the colder portions of the Colony. I have not had an opportunity of seeing either of them growing. Every effort should be made to extend the culture of the walnut, a tree so valuable both for fruit and wood. The fruit is one which can be transported to distant

markets, or made into oil on the spot. It is stated that one-third of the oil made in France is from walnuts.

The Cape fruit tree par excellence is the orange, and here there is the melancholy story of ruined proprietors, owing to the ravages of the Dorethesia. Very little remains now of the formerly magnificent orange groves in the old settled country in the west of the Colony. The Dorethesia, or Australian bug, as it is erroneously called (for it is stated to be unknown in Australia), has not spread much in the east of the Colony, but it exists at King William's Town and at Port Elizabeth. In the eastern part of the Colony there are not the large orange groves which existed in the west. Still, oranges have been extensively planted, and they are now in much the same plight as are the vines of Italy and Switzerland, with the dreaded Phylloxera on the other side of the Alps. As a tree the orange flourishes luxuriantly throughout Cape Colony, its branches bent with the burden of fruit, and the air in spring heavy with the scent of blossom ; the fruit of a size and sweetness superior to that from the hills in South India. Lemons flourish equally well. Limes perhaps better in India than in Cape Colony. I gathered some fine lemons in a garden a few days ago, the proprietor of which was positive that the trees had grown from orange pips. He sowed the pips with his own hands, and accounted for the result by the fact that the oranges were from trees grafted on lemon stocks ! A small scaly organization called "bug" prevails on orange trees here, as in America and elsewhere. This tendency to suffer from "bug" is probably exaggerated by the method of propagation adopted : fresh seed might produce hardier trees. There is an orange smaller than the ordinary fruit with a loose skin, and known by the Dutch name of Natje.

Quince hedges, peaches, and fig trees are met with everywhere, so abundant are these fruits sometimes when the rains are good, that even near large markets they are often unsaleable, and left to rot on the ground.

Apple trees require more care than in England, and the trees I have seen were bushy and stunted compared to the apple tree of Devonshire orchards. In the warmer parts of the Colony, apple trees frequently bear fruit twice during the year. Apple trees do better in the west of the Colony, where as in South Australia there is a wet Europe-like winter. I have no personal knowledge of the flavour and abundance of Colonial apples, but an improvement may perhaps be expected on the vaunted produce of Bangalore, where I have seen Madrassis pay for sour apples their approximate weight in silver.

Pomegranates and loquats grow well as would be expected.

Bananas grow fairly in Cape Colony anywhere near the coast, and where there is water sufficient to irrigate them ; but they are rarely planted, and most of the fruit on the coast markets is brought from Natal. Two kinds of bananas are met with, one

called 'banana,' and the other known by the curious Anglo-Indian appelation of 'plantain.' The names probably indicate that one kind was originally brought from India, and the other from the West Indies.

Climate of Cape Colony.—A popular description of the climate of Cape Colony would be that the winter half of the year is like a dry summer half of the year in England, and the summer half of the year in Cape Colony like an Indian winter half of the year. The mean temperature of the summer half of the year in England (April to September) is 56° Fah.; of the winter half of the year in Cape Colony 57° Fah. The mean temperature of the summer half of the year in Cape Colony is 66° Fah., which is that of a cool season in India, in places where there is a cool season.

Cape Colony lies in that region, characterized by a variable and scanty rainfall, which occurs in many parts of the world, outside the influence of tropical rains and monsoons, but where the latitude is still so low as to render a somewhat heavy rainfall necessary to agriculture and the vegetation of a fertile country. Cape Colony is essentially a dry country. The temperature when uninfluenced by elevation and the warm sea current from the Indian Ocean, termed the Agulhas current, is similar to Australia in the same latitude. At Cape Town, where the climate is probably little influenced by the Agulhas current, the mean temperature of the year is 61·7°, and the rainfall 23·31 inches. Sydney, Australia, in the same latitude, has similar figures, the mean temperature being 62·7°. Adelaide, Australia, has a mean temperature of 63·70° Fah., and a rainfall of 19·87 inches, but the high mean daily range of 20·98°. At Adelaide, Australia, as at King William's Town, and some other places in Cape Colony, the thermometer occasionally rises to 115° in the shade when a hot wind is blowing.

The mean temperature and rainfall and mean daily range for each month at Cape Town are as follows:—

Meteorology of Cape Town.

Temperature.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly mean.
Mean temperature, ..	° 68·77	° 68·99	° 66·29	° 62·95	° 58·01	° 55·85	° 54·57	° 55·21	° 57·43	° 61·06	° 64·28	° 67·61	° 61·71
Mean daily range, ..	11·13	11·76	12·28	11·26	9·17	8.66	9·07	8·89	9·41	10·36	10·84	11·46	10·82
Rainfall, ..	″ 0·880	″ 0·658	″ 0·846	″ 1·846	″ 3·576	″ 4·811	″ 2·921	″ 3·823	″ 2·382	″ 1·014	″ 1·090	″ 0·516	″ 23·309

These are established figures taken at the well known Cape Town

observatory, an institution inseparably connected with the name of Herschel, and which remains still an Imperial establishment. Only a comparative value can as yet be attached to figures from other stations in the Colony. Valuable work is now being done by a Meteorological Commission, but this has not been established a sufficient number of years to afford reliable averages. Briefly, it may be stated that commencing at Cape Town, of which the meteorology is summarized above, as soon as the Cape peninsula is doubled, the influence is felt of a warm sea current which comes from the Indian Ocean, and sweeps round the whole south-east and south coast of Africa, as far as the Cape peninsula. An antarctic current cools the dry west coast of South America ; but South Africa has unfortunately a warm gulf stream, where an antarctic current would be more in place. The difference in the temperature of the sea at Cape Town and at Simon's Town, places within a few miles of one another, but on opposite sides of the Cape peninsula, is stated on good authority, to be as much as 15°: and going eastward, while the latitude remains practically the same, there is a gradual rise in the mean temperatures, and a change in the flora towards subtropical species. The heaths, with the exception of two or three species on the eastern high lands, are confined to the western side of South Africa. The silver tree, *Leucadendron argenteum*, does not show its curious foliage outside of the Cape peninsula. It is in the west that grow those beautiful bulb flowers, *Gladiolus*, *Watsonia* and other *Iridiæ* and *Liliaceæ*, which have spread the Cape flora over the gardens of the civilized world. Going eastward, as with heaths and Proteas, comparatively few bulbs survive on the hills and mountains of Caffraria. Of the large Cape genus of *Cliffortia*, one species extends from Cape Town to Natal, but Dr. Harvey states that "the great majority of the other species scarcely extend further east than Swellendam." In the west the staple cereal is wheat, in the east maize. Again, let us take a few well know Indian and tropical genera, and notice their distribution in South Africa. There is one indigenous palm in Cape Colony, *Phœnix reclinata:* this has very much the appearance of the common *Phœnix sylvestris* of India: it occurs on the east coast, and may be said to accompany the Agulhas current as far west as George. There are two or three species of figs indigenous to South Africa, first met with in the east of Cape Colony and becoming more abundant in Natal. Probably every Indian Forester has come in contact with the genus named after the brothers Bauhin. Our Indian friend *Bauhinia* crops up again in South Africa. (I quote now from Dr. Harvey's "Genera of South African Plants," a book edited by Sir Joseph Hooker, and one which, he who dips into a new flora will congratulate himself on having found.

"*Bauhinia.*—Trees or climbing shrubs, chiefly tropical ; at least four South African species, all but one eastern."

To take another genus equally well known in India. "*Cassia.*—A vast tropical genus, much diversified; about four South African species, all eastern or from Natal."

Again, *Dalbergia.*—"Trees or climbing shrubs of warm countries. Three species in Caffraria and Natal."

Zizyphus.—"Three South African species from the northern and eastern districts."

Mimusops.—"Three or four species in Caffraria and Natal."

Croton.—"Shrubs or herbs tropical and sub-tropical. Two or three species (Cape) in the eastern district and Natal."

Eugenia.—"About eight species (some undescribed) all eastern or from Natal."

Loranthus.—"A large chiefly tropical genus: twelve (or perhaps more) Cape species, all natives either of the eastern district or of Natal."

On the coast between Grahamstown and East London, tropical fruits, such as the pine-apple, mangoes, plantains and coffee, succeed in situations sheltered from the dry cold land wind.

The origin of the Agulhas current may possibly be the back wash from the flow of water which sets in from the south to supply the fierce evaporation in the Indian Ocean. Whatever the origin of the Agulhas current, its existence and influence on the climate of South Africa are incontestable. Inland, the influence of this warm sea current is soon corrected by the increasing elevation of the country. From the southern coast the country rises, sometimes gradually, and sometimes by steps, to the high plateaux of the interior. At 50 miles from the coast the average elevation is probably about 2,000 feet. Bloemfontein the capital of the Free State, is at an elevation of 4,500 feet, and has a mean temperature the same as Cape Town, with its fresh winds from the Atlantic. The Diamond Fields, and the greater portion of the Transvaal, lie at an elevation of about 4,000 feet. Thus, from the coast to the tropic, owing to the increasing elevation, there is little difference in mean temperature. Proceeding inland, the climate of course assumes continental characteristics. It becomes brusquer, with a higher daily range, and more difference between summer and winter. Elevation in Cape Colony appears to have less influence on temperature than in England or India: this is probably due to—1*st*, the dryness of the atmosphere; 2*nd*, the high plateau character of the interior. In India the difference between the temperature of stations on the hills and on the plains is usually less during the dry season. And on plateaux, or ground rising gradually, the fall of temperature for elevation is always less than on the top of steep mountains; except in the case where the high land is covered with snow, and then the reverse often happens as in Switzerland, where cold winds sweep down from the mountains. The cause of this is sufficiently obvious in the rarification of the air and its subsequent passage over ground

heated by the sun, or cooled by snow or evaporation. In South Africa snow lies on the mountains for a few days during winter from about 3,000 feet upwards; but South African snow is too limited in area to have any appreciable effect on the climate.

Roughly, the rainfall may be stated to vary between 15 and 20 inches, according to local influences, diminishing to nothing towards the rainless deserts of the north-west. In the beautiful forest country of the southern coast, and of the eastern mountains, the rainfall is greater, as also in Natal, the garden of South Africa, where it assumes tropical characteristics. The rainfall more than the mean temperature, emphasizes the marked difference between the climate of the east and of the west of Cape Colony. The west, with its winter rains and dry summers, has a climate readily comparable with that of South Italy. In the east, dry winters are the rule, winters in which the coldness of the air is marked by the warmth of the bright sun, and in which the damp and bracing continuous cold of a European winter are absent. In considering the influence of winter and summer rain on vegetation, the different value of the same quantity of rain falling at different air temperatures, has to be taken into account. An inch of rainfall, distributed over a month with temperatures within the degrees of 40 Fah., and an English October sun, will keep the ground soaked and all vegetable tissue turgid with moisture; while 20 *inches*, under a tropical sun, will not have the same soaking effect on vegetation, supposing (what rarely happens with tropical rain) that it also is evenly distributed throughout the month. Thus in summer, in England, we look for finer weather, but not for absolutely less rain, than in winter. The spring is the slightly driest season of the year in England. Thus again, an annual rainfall of 18 inches is amply sufficient for agriculture in England; but it represents a woefully inefficient figure in South Africa, with its higher temperatures, its warm sun, and its drying winds. Thus again, the west of Cape Colony, and South Australia, with their winter rains, are more Europe-like, and better wheat and vine-growing countries, than the east of Cape Colony with its summer rains. Fortunately for the east of Cape Colony, the summer rains extend irregularly early and late; and thus much rain falls economically during the prevalence of comparatively low temperatures.

In the South African climate, the dry hot winds are a noticeable feature. All northerly winds, are necessarily winds, which become more or less dry and warm, as they descend more or less undiluted towards the coast. A cool ascending wind is more likely to progress undiluted than a warm descending wind. But unfortunately, in Cape Colony, northerly winds are more prevalent than southerly winds. The winds are quite free from the regular character of monsoons, but, speaking broadly, south-east winds prevail in summer, and north-west winds in winter. But

even in summer it is doubtful, whether away from the immediate neighbourhood of the coast, as much rain does not fall with northerly as with southerly winds. Thus most parts of Cape Colony are subject to rapid changes of temperature, changes which afford continual relief, and break the monotony of the long Cape summer, of eight or nine months' duration. There are days in midwinter, when the air temperature is as high, and the sun as hot, as in midsummer in England; and there are occasionally cold days in midsummer, when snow falls on the mountains, and a fire would be pleasant to a dweller in the plains. On the 4th of last December the newspapers reported injury to crops from frost in the higher districts during the night; the preceding day had been fresh and, out of the sun, cold enough to make a great coat or a fire acceptable.

A week afterwards it was reported that the crops were suffering from excessive heat. The following is a cutting from the "Kaffrarian Watchman" on the subject:—

"During the last few days the heat has been most oppressive, but upon no other day has it been so hot as it was upon Thursday last, when the thermometer stood at 171° in the sun and 112° in the shade. The following are the maximum temperatures for the last four days (in King William's Town, 1,200 feet above, and 85 miles from, the sea):—

		In sun.	In shade.
"December	9th, ...	160° ...	109°
"	10th, ...	145° ...	95°
"	11th, ...	157° ...	108°
"	12th, ...	149° ...	103°
"	13th, ...	171° ...	112°

"This return shows that we have worn out an existence during the last four days under an average maximum temperature of 156·2° in the sun and 105·2° in the shade. Yesterday as the Grahamstown post cart was coming to town, and when between Iquibica and Debe Nek, one of the horses dropped dead while in harness. The cause is attributed to the excessive heat which prevailed."

A touch of this warm wind in an undiluted form appears to have reached the coast. The following is cut from an East London Newspaper:—

"A blast of hot wind passed through East London between 9-30 and 10 A.M., on Thursday last. It came right down Oxford Street and nearly stifled the town. Fortunately it did not last longer than about half-an-hour, but old Colonists say that in an experience of 40 years and more they never felt such heat. We expect to hear of scorching weather inland."

As in all dry countries, there is in Cape Colony usually a sudden fall of temperature at sunset. Except near the coast an unpleasantly warm night is nearly as rare as in England. But (as I think poor Trollope remarks) as regards the work-a-day temperature there is a great difference between England and Cape Colony. Here the temperatures lie somewhat more than half way between the invigorating cold of England and the

enervating heat of India: but the cold nights, the rapid changes of temperature, and the non-malarious character of the country, combine to render the climate one in which most English (and German) constitutions find a home, and most North European trees and vegetables, an easy naturalization. Plants and animals from South Europe, find here a climate which differs from their own only in being less continuously warm in summer, and altogether milder in winter. The Dutch colonists of pure North-European descent and characteristics have been naturalized in Cape Colony for two centuries.

In conclusion, it will be right to mention that there is a general and wide-spread opinion throughout the Colony, that the destruction of forests within the last few years has had something to do with the change for the worse, which is universally believed to have occurred in the climate of Cape Colony. Now first, with regard to a change of climate, it is necessary to be very cautious in accepting the popular verdict. It is a fact, I think, that people who suffer from any inclemency of climate, either heat, cold, wetness, or dryness, become less patient, or more sensitive to the inclemency of the climate, as they grow older, and in a question of this sort it is of course only the old people who can speak from experience. Everyone is familiar with the belief prevalent in England, that the climate has changed for the wetter; but I believe that meteorological returns furnish no foundation for this opinion. The fact is that dry cold winters, being there phenomenal, are remembered; while the ordinary mild winter leaves no impression on the memory. Who has not heard of the ox roasted on the Thames? Everyone who was alive at the time would remember such a winter as that described by Gilbert White in his Natural History of Selbourne, where a quaint remark glides in of "a close warm day, the thermometer standing as high as 50°."

In Mysore the popular belief was that the climate had changed and become drier. Whenever the rains were unusually good, old officials would wag their heads and observe that this was a return to the good old days: they could remember a time when such seasons were common. Old European inhabitants of Bangalore, and in one instance, of Madras, have assured me that their climate was certainly hotter at present than it used to be. Now, when the hottest of the large cities of the world takes to becoming hotter, it is time to cry enough with popular beliefs!

Therefore, when the old Colonist tells one that Cape Colony is drier than it used to be, I take his opinion as interesting, but forbear to speculate largely on the circumstance, till the Meteorological Commission has been some years more at work.

Facts have however been mentioned to me by well informed people both in King William's Town and East London, which go a long way to prove that there is less water in the Buffalo river now than formerly. This is a river which rises in the eastern

mountains, and falls into the sea at the port of East London. It is contended that freshets are less frequent, and do not reach so high a point now as formerly, and that the flow of water in the river is less. Several well authenticated cases have been shown me where streams which, running past a farmstead and yielding always a good supply of water, now run fitfully, or have degenerated to watercourses running after rain. It would appear, therefore, either that there is actually less rain now than formerly, or that the observations on the amount of water in the rivers and mountain streams are mistaken. But people who live on the banks of a river, who have to cross and recross it continually, whose business comes to a standstill when the river is in flood, are not likely to be mistaken as to their facts when the river sinks to a poor stream, and they can get across it at all times. Or again, if a stream running from a forest-clad valley and supplying the farms below with water gradually diminishes as the forest is cut down, and finally ceases to run, there is no question here of popular beliefs, but of plain hard matter-of-fact observation. Facts such as these in the mouths of many witnesses, cannot be gainsaid ; and, while making due allowance for the water taken for irrigation within the last two decades, it is almost impossible to resist the conviction that in the eastern forest country of Cape Colony the rainfall has diminished to some extent within the last 15 or 20 years. That the water available for irrigation in the rivers and streams is less there can be no doubt.

KAD-HANDI.

GROWTH OF GRASS AND UNDERWOOD UNDER THE SHELTER OF TREES.

THE *German Botanical Society*, which was founded in September 1883, has started with great activity. A large volume of 546 pages, with numerous plates, embodies the work done during the first three months of its existence. This volume comprises, among other important papers, some *contributions which* may interest Foresters in India.

On page 108 *Fr. Buchenau* of Bremen, the well known author on *Tuncaceæ*, draws attention to what he considers the *manuring power of the* rain water which drops from the crowns of isolated trees. I will give the substance of his remarks as much as possible in his own words.

"Where, in the neighbourhood of Bremen, isolated (deciduous) trees with their crowns high above the ground, stand in meadows, on pasture land, or on the turf of parks, the grass under the crown in early spring is always far in advance of the grass in the open. *As far as the branches of the trees* reach, the grass is bright green, new leaves have developed,

while in the open, the grass still wears its dull brownish winter color, without any fresh leaves. In spring the grass under the trees is a week and sometimes a fortnight ahead of the grass in the open. Later in the season the difference is less marked and sometimes disappears entirely, but even in summer the grass under isolated trees is often heavier than in the open. That the grass is killed out by the shade of trees, which stand close together, or the foliage of which hangs close over the ground, is a well known fact, which requires no explanation."*

So far Buchenau. On page 471 of the same volume another Botanist, E. F. von Homeyer, confirms these observations as far as the lime tree (*Tilia*), the beech and the maple are concerned, but draws attention to the fact, that other trees, such as the birch, have a decidedly injurious influence upon the growth of grass, which is exposed to the drip from their branches.

The explanation suggested by Buchenau is, that the rain water which drops from the leaves during summer contains salts in solution, which act as manure, and which stimulate the growth of grass in spring, before the leaves break out. In the case of trees with rough bark, the substances dissolved from the bark may also have a fertilizing effect, but Buchenau states that he has observed a more luxuriant growth of grass also under trees with smooth bark. He further draws attention to an observation published by Theodor Hartig in 1853, that the buds of the hornbeam in early spring exude drops of water in a manner analogous to the water drops found on the tips of leaves of grasses and other herbaceous plants. The water which is thus exuded, contains small quantities of salts in solution, and may thus have a fertilizing action.

The well known more luxuriant growth of grass and herbs on mole heaps, Buchenau mentions as an analogous fact. In the case of the mole heaps, vegetation is stimulated by the loosening of the soil, while under the crowns of trees in spring the more luxuriant growth of the grass is ascribed by him to the fertilizing effect of the drip from the foliage during the preceding summer, and to the drip from the buds during spring.

Other explanations, besides that, on which Buchenau lays stress, readily suggest themselves. The fertilizing effect of the leaves, twigs and pieces of bark which drop from the tree, and parts of which remain and decay on the ground under its branches, must be considerable, and on pasture land is added to this the manure left by cattle, which congregate under the trees. Another cause of the earlier developement of grass under trees in early spring is the protection against radiation and frost afforded by branches, even while leafless.

In India circumstances are in most cases different. As far

my recollection serves me, I have not noticed a more luxuriant growth of grass under the trees on the Calcutta *maidan*, but in the drier parts of the country grass and herbage grows more luxuriantly under, and in the vicinity of, isolated trees. Dense shade of trees growing close together, or with their crowns near the ground, kills out grass and herbs in India as well as in Europe, and if this were not the case, fire protection in India would be a hopeless task, but the shelter of partial shade promotes the growth of herbs and grass, particularly in the drier regions of India, and the chief cause of this beneficial influence is the protection which trees afford against the sun and against scorching dry winds. The provision of more abundant fodder during seasons of drought and scarcity, through the establishment of fodder reserves, on which the growth of trees is encouraged, was based upon the observations made many years ago in Rajputana and elsewhere regarding the better growth of grass under the shelter of isolated trees.

Buchenau's paper has called to my mind another remarkable fact, which merits further study by Foresters in India. Under mango trees in Oudh, the North-Western Provinces and Burma, I have often noticed a dense growth of small shrubs and herbs, such as *Clerodendron infortunatum*, *Justicia Adhatoda*, *Glycosmis pentaphylla*. This observation relates to groves and trees not cared for, and where the undergrowth has not been killed by the tread of man and cattle. A similar growth of herbs and small shrubs I have found under mowha trees in the Central Provinces, and under a variety of trees in the Madras Presidency. An analogous fact is the springing up of a dense underwood of the mulberry under sissu trees, which I first observed long ago on the islands in the Jhelum river, and which has since been noticed at Changa Manga and elsewhere, where sissu is cultivated on a large scale. The mulberry seed is doubtless brought by birds, but its spread under the trees is promoted by the shelter afforded by them, in the same manner as the growth of beech under oak or under Scotch fir in Europe is promoted by the light shade of these trees. In the same manner we found (in 1880) under the trees of the Prome teak plantation, which I had established in 1857, an underwood of evergreen trees and shrubs, such as *Strychnos potatorum*, *Ægle Marmelos* and *Ulmas integrifolia*. These instances of dense undergrowth under trees with light cover, such as teak and sissu, might be multiplied, and they are not surprising, but the luxuriant growth of herbs and shrubs under trees with dense foliage, such as the mango, is remarkable, and shows how much more powerful the sunlight is in the tropical and subtropical districts of India, than in the higher latitudes of northern Europe, where shade equally dense would kill all grass and herbs on the ground.

Analogous facts are common in India. Under the dense

shade of the evergreen forest in the Thoungyeen valley and elsewhere in Tenasserim, as well as along the Western Ghâts of the Peninsula, the ground is not bare as we find it under forests of beech and silver fir in Europe, but the space between the stems is filled up by a great variety of shrubs and large herbs, and among them are numerous seedlings of the trees which compose the forest, maintaining their existence without making much progress, until an opening in the forest, by the death of one of the parent trees, gives them a chance. Among the herbaceous undergrowth in forests with dense shade, some of the most remarkable kinds are those which belong to the large genus of *Strobilanthes*, of which the greatest variety is found on the Nilgiris and along the Western Ghâts, but some species of which are also found under the dense shade of the alpine oak (*Quercus semecarpifolia*) in the Jaunsar forests of the North-West Himalaya.

My object in making these remarks is to induce Foresters in India, who have a taste for such studies, to collect and publish more precise observations regarding the growth of grass and underwood under the shelter of trees with light and heavy cover and in the shade of dense forest, under different circumstances and in different districts and provinces.

The formation of two annual rings in one season.—The old question, whether trees, which ordinarily form one distinct annual concentric ring in the wood, may under exceptional circumstances form two such rings, has been discussed by L. Kny in the Proceedings of the Botanical Society of Brandenburg for 1879, and by K. Wilhelm on page 216 of the German Botanical Society's Proceedings, 1883, page 216, but as yet without any finally conclusive result. Kny examined young stems of the lime tree (*Tilia*), oak (*Quercus pedunculata*) and mountain ash (*Sorbus ancaparia*), which had been eaten bare by caterpillars towards the end of June, and which had re-clothed themselves with fresh foliage during the same season. The younger branches of these trees, but only the younger, not the older branches, showed two rings in the place of one, but not everywhere, and with considerable variations as regards structure and distinctness of the second ring. A specimen of the beech on the other hand, which had also been eaten bare by caterpillars, and re-clothed itself with fresh leaves during the same season, showed one ring only of normal structure.

K. Wilhelm experimented upon coppice shoots of the oak (*Quercus sessiliflora*), seven to nine years old, in the Austrian State Forest Hinterbrühl near Vienna. From four of these stems the leaves were completely cut off with scissors, two being operated upon on 7th June, 1882, and the others on 10th July. On these four stems, as well as on one stem of the same age, selected for comparison, which had been left untouched, small

pieces of the bark were removed in different places, three on each stem, the wood laid bare being protected by a thin coating of tar. The object of these marks was to determine how far the formation of the wood had progressed at the time when the leaves were removed. Late in autumn two of the stems, which had been deprived of their leaves, were felled, and together with the stem, of which the foliage had remained untouched, they were subjected to microscopic examination. The stems bared on 7th June had on 10th July clothed themselves completely with leaves, while those operated upon on 10th July had recovered their foliage on 21st August.

As regards the structure of the wood, the stem stripped in July had laid on an extremely narrow ring, only about one-third or one-fourth of the normal width, and there was no sign of a second ring. Evidently no wood had been formed after the removal of the leaves. The stem deprived of its leaves in June showed certain irregularities in the wood, which on both sides of the marks cut into the bark, and also above and below these marks had assumed the appearance of two rings. In the vicinity of the marks, both in the stem, which had been bared, as in that which had been left untouched, a large proportion of vessels were formed in the wood, the arrangement of which, in the case of the stem, which had been stripped, gave the appearance of a second ring. But a most remarkable fact is recorded by Wilhelm, which, as he observes, is in direct opposition to that recorded by Kny, viz., that the anomalous character of the wood formed by the oak, which had re-clothed itself with leaves after having been stripped, could only be seen on the older, and was not distinguishable on the younger, branches. Kny, it is true, made his observations on *Quercus pedunculata*, while Wilhelm made his experiments on *Quercus sessiliflora*, but these two species or varieties closely resemble each other in regard to the structure of the wood and otherwise.

These researches, as far as they have gone, do not yet justify any conclusions regarding the general question, whether under certain circumstances trees form more than one concentric ring of wood in one year.

In concluding his paper, Wilhelm states that he will undertake a fresh series of investigations, and promises further communications. No enquiry on this difficult subject can lead to satisfactory conclusions without microscopic examination of the wood by a competent observer, and without a large number of experiments made on trees grown under different circumstances in successive years. If there should be any among Forest officers in provinces where the teak is indigenous or is cultivated on a large scale, who are in a position to undertake such researches, it would be well worth while to make experiments with teak similar to those made with oak near Vienna. In the Himalayan forests the ash (*Fraxinus floribunda*) or the deciduous elm

(*Ulmus Wallichiana*) with their clearly marked annual rings would be suitable trees to experiment upon.

D. BRANDIS.

IV. NOTES, QUERIES AND EXTRACTS.

MEETING ABOUT THE GRAZING QUESTION AT DARJEELING.

THE Gwallahs of Darjeeling have circulated the following petition in the station, and the question of grazing rules was discussed in a meeting of the Eden Sanatarium on the 20th May last, Mr. Home contributing a memorandum, which we give below as an extract from the "Darjeeling News." We are glad to hear that the Gwallahs have abandoned their threats of leaving Sikhim, and that the Darjeeling people get their milk as usual, though their eyes have been opened to the possibility of their milk being somewhat watered, when we consider the small number of cows, and the fact that they are said barely to yield a seer of milk each per diem.

Petition of the Gwallahs of Darjeeling to the Residents.

The Gwallahs supplying milk to Darjeeling, represented by the undersigned, beg respectfully to call upon the residents to aid them in getting their grievances against the Forest Department redressed. Last year they petitioned the Government against the oppressive exactions and restrictions of the Forest Department, but without any good result, and if the residents do not now make some satisfactory arrangement with Government, it will be impossible for the Gwallahs then to remain in the district.

The following are some of the grievances that are most intolerable :—

1*st.*—The grazing ground is insufficient and bad. The portions of forest allowed them for grazing are very steep khuds. In consequence many cows get injured or killed.

2*nd.*—The difficulty the cows have of supplying themselves with food makes the milk very much less in quantity, the majority of cows do not give even a seer of milk a day.

3*rd.*—Hence the calves (which have to be tied up that they may remain within the limits assigned) die in large numbers for want of nourishment.

4*th.*—The places where the cows are allowed to feed are scattered here and there, and this arrangement is vexatious, and the cause of disputes also obliges us to keep a large number of servants to prevent the cows straying.

5*th.*—We are not allowed to get leaves for the calves to feed on at night, this is absolutely necessary, yet the chaprasis come round, and if they find a few leaves we are invariably fined heavily from Rs. 5 to Rs. 15 for each offence. *Vide* Darjeeling Court Records.

The leaves we have taken for the calves at night are from trees that are never used save for fuel. This can be certified to by reference to the subordinate officers of the Forest Department.

6th.—The tax upon each cow has been for the last six or seven years 8 annas per month. Eight years previous to this it was 4 annas a cow, and before that 2 annas.

7th.—What we ask is that on the Ghoom spur we may have assigned a larger amount of grazing ground in one place, say on both sides of the road between Lepcha Jagat and Jore Pokri. On Senchal spur we ask for the portion up to Reshap and Sureil.

8th.—We have been always loyal subjects and law-abiding of the British Raj. In the war with Sikhim we did specially good service;—when there were few others that helped them, no Nipalees or Lepchas, we stood by them: nothing on the score of acts against law can be brought against us. We have been peaceful subjects and useful to the residents.

It is only the *zulm* of the Forest Department that has at last compelled us to the present measure. We have no wish to leave the district, but we cannot endure the present state of things.

9th.—In conclusion, the Gwallahs now represent to the Residents of Darjeeling the difficulties the Forest Department put in their way. The Gwallahs last year made a representation to Government; but without any good result, and they now ask that the Residents send themselves the matter to Government, asking Government to communicate to the Gwallahs what help they intend to give.

In case the Gwallahs get no assistance they will reluctantly be driven from the district for no cause but that of oppression, and they shall be very sorry to cause inconvenience to those gentlemen and ladies who have so long been customers, but it is no fault of the Gwallahs.

RENCHIDEN BHOOTEA.
KHEOKA BHOOTEA.
ANJOO BHOOTEA.
TASI GOLLA BHOOTEA.
JOORME BHOOTEA.
SIRPENJO BHOOTEA.
and others.

DARJEELING,
The 12th May, 1884.

MR. HOME'S *Memorandum on Grazing of Cattle for the supply of milk and butter to Darjeeling, and of draught cattle.*

The area of forests under the Forest Department included in the Darjeeling Forest Division is 64,842 acres. This includes 41,254 acres (the Singalila Range) on the further side of the Little Rangit, the whole of which range, with the exception of the Little Rangit block (2,087 acres), is open to grazing, which is also permitted in 11,397 out of the remaining forest area,

23,588 acres, so that out of a total area of 64,842 acres, 14,278 acres only are closed against grazing. Omitting the area on the further side of the Little Rangit, there are 11,397 acres on which grazing is permitted ; the last returns (April 1884) show that 334* cattle (including draught cattle) pay for grazing on this area, which gives over 33 acres of pasture land to each head of cattle.

From the above figures it will be seen that half the area of the forests under the Forest Department within a reasonable distance of Darjeeling, and on which the Department has to rely to meet the requirements of public works, the general public, and residents of the station in timber and fuel (which requirements are undoubtedly on the increase) is, under Government orders, left open for the grazing of cattle for the supply of milk and butter to the station, and of draught cattle.

In the memorandum on the management of the forests in the Darjeeling Division, April 1882, Dr. Schlich, the Inspector-General of Forests to the Government of India, went thoroughly into the grazing question.

He allows for 310 head of milk cattle for the Darjeeling supply, besides 120 draught cattle, and set aside the following blocks of forest for their grazing :—

Approximate distance to centre of block from Observatory Hill, Darjeeling, in miles, omitting fractions under half a mile.		Forest block.	Area, in acres.	Number of cattle paid for grazing in April 1884.
In a bee line.	By road.			
		For Darjeeling Supply.		
3½	5	Senchal, ...	517	26
4	7½	Tiger Hill, ...	755	18
3½	8	Rangjo, ...	1,100	29
6	9½	Balasan, ...	811	24
		Carried over, ..	3,183	97

* This figure 334 was supplied to me when drafting this portion of my note on the 11th May. On going into details in the table given above, I find the actual number of cattle to be 234 in April, and that it was 272 in March. The average area for cattle in April was therefore over 48 acres per head.

Approximate distance to centre of block from Observatory Hill, Darjeeling, in miles, omitting fractions under half a mile. In a bee line.	By road.	Forest block.	Area, in acres.	Number of cattle paid for grazing in April 1884.
		Brought forward, ..	3,183	97
		For Darjeeling Supply.		
6	9½	Chongtong, ...	1,047	16
8	14	Parmaigiri, ...	1,284	4
7	14	Palangdong, ...	931	7
8½	15	Pagrainbong (part), ...	400	19
6	14	Tukdah, ...	668	12
		Total, ..	7,513	
		For Kurseong Supply.		
5½	7½	Pachim, ...	468	..
7	9	Chattackpur, ...	875	43
		Total, ..	8,856	
		Subsequently opened at the request of the Deputy Commissioner under Government orders.		
4½	6½	Sonada, ...	665	..
5	10½	Rangbi, ...	1,037	4
3½	6½	Nai, ...	839	32
		Total, ..	2,541	234
Average distance 5½	9½	Grand Total, acres, ..	11,397	..

The Pachim and Chattackpur blocks, though opened for the Kurseong supply, are really used for the Darjeeling supply.

The actual number of cattle paying for grazing last month on this area was 334; and Government ordered these last three blocks to be opened, as it was considered that Dr. Schlich's estimate of the number of cattle to be grazed was under the mark. The result however shows that Dr. Schlich over-estimated the number of cattle to be provided for.

With reference to the specified complaints of the Gwallahs :—

1*st.*—Last rains they complained of one block only, the Nai block, being too steep for grazing.

This block was recently visited by the Deputy Commissioner (Mr. Wace) under the orders of Government, and it was decided (Tenduk, Tehsildar, concurring) that with the exception of about one-fourth of its area (or 210 acres), there was no just ground for the complaint.

2*nd.*—The area open for grazing within reasonable distance of the station is over 33 acres per head of cattle, which must be admitted to be ample provision for the purpose.

3*rd.*—The calves are stall-fed, or graze with the cattle at the option of the graziers, who are allowed to cut grass and bamboo leaves for them free of charge. It is only when the branches of trees and saplings are cut for this purpose that the Forest Department raise any objection.

4*th.*—The blocks open to grazing are contiguous in the following groups :—

				Acres.
Senchal,	...	...	...	
Tiger Hill,	...	...	...	
Rangjo,	...	...	...	
Rangbi,	...	...	...	5,417
Sonada,	...	...	...	
Pachim,	...	...	...	
Chattackpur,	...	...	...	
Balasun,	...	...	...	
Chongtong,	...	...	...	
Parmaigiri,	...	...	...	4,473
Palangdong,	...	...	...	
Pagrainbong,	...	...	...	
Nai,	...	...	...	839
Tukdah,	...	...	...	668
		Total acres,	...	11,397

5*th.*—The fines referred to are judicial fines, and with the very small staff we have, it may be safely assumed that for one offence in which the offender is caught red-handed (we cannot prosecute in any other case), fifty are committed of which we know nothing except the results to the trees in the forests.

The damage done by lopping is so serious, that special rules for stopping it have for some time been under consideration.

6*th.*—The question of grazing blocks, &c., was fully gone into in 1882-83, and in February 1883, *all* graziers came up to the Forest office to settle in what blocks they were to graze, in accordance with the proposal of the Deputy Commissioner. No question was *then* raised as to rates, nor have the rates ever been objected to. The complaint is obviously altogether frivolous, as this is the first time they have said anything about it in seven years, and the remedy is in the Gwallahs own hands.

7th.—See Map.—The area open on the Ghoom spur in one continuous block is 4,473 acres. They have the *whole* of the land on both sides of the ridge from Lepcha Jagat to Jore Pokri, with the exception of a strip of about half a mile on the north side of the ridge at Lepcha Jagat.

On Senchal spur they have a continuous block of 5,417 acres; *they have the whole of the portion up to Suriel and Rishap,* including those blocks, with the exception of the Rungbul block (650 acres).

Whoever the writer of the petition may be, he evidently does not know anything about the country, and did not take the trouble to study the map. If the Gwallahs had written the petition themselves, it is impossible that they could have made the mistake of asking for what they have already got.

8th.—One complaint only has come to my notice since I took charge in December 1882, which the Forest officer made over to *the Deputy Commissioner for disposal.*

I find no record of a complaint of any sort against the subordinates of the Department before I took charge.

9th.—If by "help" the Gwallahs mean that they require a larger area for grazing, the Forest Department cannot assist the residents in getting over the strike with which they are now threatened.

The Department has already, under Government orders, opened a considerably larger area than was deemed safe by their Inspector-General, and if the Gwallahs consider the 33 acres per head of *cattle that are now open for grazing to have become too* poor for that purpose, this result can only have been attained by their own actions, and no doubt chiefly owing to their wanton practice of lopping, and thus depriving the soil and young growth of their natural protection.

As to the suggestion that the blocks of forests soon to be cut over for the supply of timber and fuel to the station, and regenerated could without damage be opened to graziers, the absolute necessity for keeping such blocks closed to grazing for a number of years before they are worked has long been recognized. Were *cattle admitted, the whole of the young growth, on* which the regeneration has chiefly to depend, would disappear, and the cost of re-stocking the area would be very greatly increased.

General Remarks.—The Forest Department have given up more than half of the available area of forest within a reasonable distance of the station already.

The area per head of cattle is very large indeed (33 acres), notwithstanding which the graziers complain that the land open to them is too poor to support their cattle. The area under the Department *is deemed barely sufficient to meet the demand* there is on it for timber and fuel. The portion that has already been grazed over is practically cleared of young growth by the

grazing, and the older growth is gradually being killed out by the lopping. The absence of young growth is not in itself an insurmountable obstacle to regeneration, if the areas opened to grazing are judiciously selected, but the lopping does not only very seriously retard the regeneration of any given area; it makes the subsequent re-stocking of the forest a very slow and expensive operation, and greatly diminishes the outturn of the old stock.

If the supply of timber and fuel to the station and Public Works from the area under this Department is to be sufficient and continuous, there is no doubt that this practice of lopping must be put a stop to altogether. The Department has tried to stop it for the last 15 years by warning and occasional prosecutions under the law in force. The evil has become so great, that it is feared unless special measures are adopted in the form of severe rules passed under the Forest Act, the forests under this Department might eventually be reduced to a state similar to that in which the municipal land near Ghoom now is.

My attention was drawn to this soon after I took over charge of the Department, and the matter was brought to the notice of the Deputy Commissioner towards the close of last year.

The following draft rules under section 75 (d) of the Forest Act are now under consideration before submission to Government, which though some may consider severe, are not deemed by the Department to be more so than the exceptional circumstances of the case require.

"Every grazier occupying a *bathán* or grazing camp within the boundaries of the reserved forests of the Darjeeling Division, will become liable to fine and payment of compensation, as defined in section 25 of the Forest Act, for every tree or sapling that may be lopped or in any way damaged by a cutting instrument, within a radius of 800 feet from the site of his *bathán*, unless he shall have made a report to the nearest Forest officer or Forest guard within three days of the occurrence of such damage, and afforded reasonable assistance towards the apprehension and conviction of the offender."

A similar rule is in force in all State and Communal forests in France, and is given in Article 45, Code Forestier.

If it is considered inadvisable to pass a rule that bears only on a particular class of persons who frequent the reserves, the following rule has been suggested as a substitute.

"Whoever is found in a reserved forest in the Darjeeling Division off the ordinary roads and paths having in his possession bill-hook, axe, saw, or other cutting instrument of like nature, without a license according him permission to carry such instrument, shall be punished with a fine of from one to ten Rupees for each offence, and with confiscation of the said instrument or instruments."

A similar rule is in force in all State and Communal forests in France, see Article 146, Code Forestier.

DARJEELING,
The 18th May, 1884.

P.S.—As there was an error in my note as regards the number of cattle grazed, I give below the actual number that paid for grazing for the last three years:—

				Average for month.
1881-82,	...	4,198	...	350
1882-83,	...	4,972	...	414
1883-84,	...	3,765	...	314

The falling off in last year is due to the cart traffic having grown less since the reduction of rate on the railway.

The cattle that grazed in 1883-84 were distributed among the blocks open for grazing as follows:—

Forest block.	Cows.	Buffaloes.	Bullocks.
Senchal, ...	137	0	24
Tiger Hill, ...	98	0	0
Rangjo, ...	558	0	0
Balasan, ...	283	0	0
Chongtong, ...	220	0	0
Parmaigiri, ...	200	63	0
Palangdong, ...	476	51	0
Pagrainbong (part), ...	78	158	0
Tukdah, ...	262	0	0
Pachim, ...	35	0	0
Chattackpur, ...	36	21	449
Sonada, ...	0	0	152
Rangbi, ...	118	0	0
Nai, ...	310	0	36
Total, ...	*2,811*	*293*	*661*
Average per month, ...	234	25	55

21st May, 1884.

GOATS, FORESTS AND FAMINES.—The remark that great events often arise from very insignificant causes, though far from original, is nevertheless true. The statement holds good in the moral, physical, and political world, and numerous instances might be given in each case. The white-ant is able to undermine large

buildings and destroy valuable property; a little insect, it is said, raises the large coral reefs in the South Sea, those terrors of the mariner and cause of so much loss. In the same way, it is believed that the goat has a good deal to do with the terrible famines that now and again visit this land. The connection may not at first sight be apparent; in fact, cause and effect may not seem plainer than the Goodwin sands and the church which stands close, and which always go together in the minds of sailors. But if we look a little further, we shall find that to these little animals may be set down the loss of life of thousands, perhaps millions, of people. The explanation is this. The goats destroy the young trees, and thus lay the land bare, when famine follows. Many of the forests that have not been cut down are simply used as grazing ground for cattle, sheep, and goats, and though the two former do much harm, the loss caused by them is small as compared with that brought about by goats. There is another way in which these creatures cause much harm. In spite of the daily and largely increasing demand for fuel, during the past twenty-five years more specially, the jungles and forests bordering the water-courses would not have undergone such utter extinction as they actually have, had it not been for the ravages committed by sheep and goats. The subject has never been brought into prominence until very recent years; but now when the labours of naturalists and physical geographers have shown how nice and exact is the balance through all nature between the *fauna* and *flora* of a country, and how disastrous the effect upon the one may be from a disproportionate activity of the other, there is no further excuse for shutting our eyes to the necessity of remedying the grave evil which has already been occasioned on this head in different parts of India. If we take the Madras Presidency we shall find that there are probably more than fourteen millions of goats, a number so manifestly in excess of what the present scanty pasturage can support, that the reason is plain why the young forest trees of the country have no chance of existence, and why the water-courses upon whose banks their stunted skeletons grow are merely dry ravines, filled up with stones and sand. We are told by a traveller how the introduction of goats into St. Helena utterly destroyed a whole *flora* of forest trees and with them all the insects, *molusca*, and perhaps birds directly or indirectly dependent upon them. And though of course the limited area of that island, and the unlimited powers of reproduction inherent in goats, made the catastrophe which supervened in St. Helena more evident and decisive, there cannot be the slightest doubt that the very same process of destruction is going on over the whole of India.

It has been stated—and we see no reason to doubt the statement—that the barrenness of Central Asia is due, in a great measure, to the destructiveness of the flocks and herds of the nomadic tribes. A traveller visiting this part of the world says:—

"It was in the Kizzilkoom desert that I first appreciated the enormous force of these scourges. Once, as evening fell, I met a flock of goats advancing across the wilderness in a compact mass, one of whose points was occupied by the leading animal. The dimensions of this moving mass I judged to be about 150 yards long by 100 broad, and its area would, therefore, have been 7,500 square yards, and allowing two animals per square yard, there were 15,000 goats in the flock! During the whole of the day those animals had been scouring the adjacent country for miles in search of food, and every young shoot of vegetation they found must have been destroyed! Under such circumstances, is it any wonder that no water is to be met with, and that nature presents such unchangeable and persistently repellent aspects for mankind in regions where the youth of our race was passed?"

To a certain degree the same animals are rendering parts of India unfertile, by destroying the trees and stopping the water-courses, thus changing the character of the rainfall, thereby bringing about famine, and causing loss of revenue and loss of life. It has now been pretty well settled that rainfall and forests are intimately connected; that where the latter are destroyed, the former becomes irregular, and in certain cases ceases altogether. There are points about the subject that it may be difficult to explain; but the mind that cannot connect the different links in the chain between forests and rainfall must be remarkably constituted. Marsh settled the question years ago, and his work is unanswered and unanswerable. Before the destruction of the forests in Mysore the rainfall was regular, while, although we may have an average during the year, it may come down at any time. Last year we narrowly escaped a famine. If the rain had not fallen when it did, there would have been a repetition of 1876, and the loss to the province would have been something terrible. The lesson to be learned is obvious. The conservation of the remaining forests ought to have more attention paid to it, and for every tree cut down another ought to be planted. The whole subject has been neglected too long, and Government should take the matter up as one of vital importance. It is hard to say what ought to be done with regard to the destructive qualities of the goats, but the subject is well worthy the attention of a Government that professes to have the welfare of the people at heart.—*Bangalore Examiner*.

ARTIFICIAL INDIA-RUBBER.—India-rubber and gutta-percha have become of such universal use, especially for telegraphic and surgical purposes, and so much concern has been from time to time expressed that the artificial production of these products would interfere with the regular growing of this plant in India, Ceylon, and other countries, where the rubber tree is

indigenous, that a brief mention of the various chemicals more or less suitable for its production may be of interest. Sulphur of course stands pre-eminent, fulfilling as it does many of the requirements necessary for a substitute. It is unattacked by acids, alkalies or salts, and when melted its great brittleness gives place to a softness, pliability and even elasticity, if properly treated by being poured into cold water while in a liquid state. To obtain this elasticity however it must be dissolved twice (at different temperatures), as it is only after its second melting that it possesses to any extent the elasticity of rubber. Alumina soap has been much experimented with. Its tenacity is undoubted, and it undergoes many curious changes when melted with resin and thick linseed varnish. A German scientist has I hear even patented a composition of sulphur, copal, oil of turpentine and albumen—with what success is not yet known.

A substitute for India-rubber must, however, fulfil two most important conditions. It must be *cheaper* and it must retain its elasticity *permanently*. In view of the high prices commanded by India-rubber, many materials can be found which will fulfil the first requirement—that of comparative cheapness. But it is in the latter important particular that all artificial substitutes have so far failed. Sulphur, if properly proportioned in its melted state with linseed oil varnish, can be rendered permanently soft, but this is of course a very different condition to elasticity. The only direction in which chemists are likely to be at all successful in producing a real substitute for rubber is by looking for some permanently elastic substance which will destroy the crystalline structure that makes sulphur so brittle, and render it impossible for it to return to its former condition ; and it is in this direction only I think that comparative success may be looked for. It will however always be difficult to imitate this elasticity, and the substitutes for India-rubber will meanwhile only find use where this elastic property does not come into prominence.—R. K. J.—*Indian Agriculturist.*

DIETRICH BRANDIS,
The Founder of Forestry in India.

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DIETRICH BRANDIS,

THE FOUNDER OF FORESTRY IN INDIA.

WE have ever since Mr. Brandis said his last farewell to India, considered it our duty to place before our readers a short history of the introduction of scientific forestry into the Eastern Empire, which would mainly be an abstract of the work done by the eminent founder of our department. The only excuse for delaying this till now we are able to offer to the public and our retired chief is that, in his organization of the department he has provided us with work and public duties sufficient to leave but little spare time for a labor of love.

Even now the record we are able to compile can profess to be but a scanty representation of 27 years of untiring and arduous work. The results of this life of labor have no doubt been brilliant, and may be gauged by the public at large, but its utter unselfishness and devotion can only be understood by a few initiated, who have themselves lived through the early struggles of forestry in India, or who have made the growth of our beloved science in this empire a special study.

Sporadic attempts at forest conservancy had been made, especially in Burma, where the value of forest produce at once attracted public attention, previous to Mr. Brandis' era, but of whatever value such attempts may have been at that time, they were founded on no sound basis, and have long since disappeared, leaving as sole traces of their existence a few impracticable leases as usual entirely in favor of mercantile pioneers, as people who cut down a virgin forest for their own profit are pleased to call themselves. In spite, however, of the but temporary success consequent to opinions and events over which the originators had no control, we must note the sound proposals made, and the important measures introduced, by Dr. Wallich and Captain Gathin as early as 1827 and 1845, which are duly recognised in Mr. Brandis' report on the Attaran forests of 1860.

In January 1856 Mr. Brandis was appointed *Superintendent* of Forests in Pegu, in British Burma, and in 1857 the forests of Tenasserim and Martaban were added to his charge. In this

position he remained till December 1862, when he was translated to wider duties under the Government of India.

Mr. Brandis' work in Burma forms, therefore, the first period of his Indian career, and not the least brilliant one.

Immediately after his arrival Mr. Brandis proposed to himself three questions as the first ground work to the introduction of a sound administration of the Pegu forests. These questions, simple in themselves, proved at once that the Government had secured the services of an officer of a very superior common sense and judgment; and the way in which the answers to them were worked out, in spite of all difficulties at the cost of untiring labor and severe hardship with utter disregard to personal comfort and convenience, and even at the sacrifice of health, must ellicit our highest admiration.

The questions were :—

1. How can the produce of the forests be turned to account in the most advantageous manner?
2. What measures must be taken for the preservation of the forests? and
3. What can be done for the extension and consolidation of the forests?

To answer the first question it was of course necessary to form some estimate of the amount of timber the forests would be able to yield without deterioration, and the first step was naturally to make a valuation of the growing stock.

Here again Mr. Brandis hit the nail on the head, and introduced a system of valuation surveys, so eminently adapted to the circumstances, that with but slight modifications it is still in force up to the present day.

"Linear Valuation Surveys," it is thus Mr. Brandis has named his method, excels by its simplicity. The trees along certain lines, roads, ridges, streams or lines chosen cross country are counted, classified according to their girth, and ticked off on small pieces of bamboo, split into thin strips, each of which is again notched into ten pieces, which can be turned down one by one. Different pieces are carried for the different classes of trees. This shift is extremely useful in a country like Burma, where on account of rain or dew it is often difficult to use a pocket book.

At the beginning all trees that could be seen from the line traversed were counted, but though this method gave a fair idea of the character of the forest, it was soon found that it was preferable to substitute a fixed distance, in order to obtain a fixed factor on which a somewhat more accurate estimate for the rest of the forest areas under observation could be formed. The distance on which the trees were thus counted was at first fixed at 100 feet, but subsequently, on account of the frequently extremely dense growth of the Burma forests, at 50 feet on each side of the line traversed.

Mr. Brandis made of course the teak, which at that time was the only tree the extraction of which was at all remunerative, the main object of his observations, and divided them at first into four classes—

I. Trees of 6 feet (4 cubits) and above in girth.
II. Trees of 4 feet 6 inches to 6 feet (3-4 cubits).
III. Trees of 3 feet to 4 feet 6 inches (2-3 cubits).
IV. Trees under 3 feet (2 cubits) girth and seedlings.

Subsequently these classes were re-arranged, and all trees down to 1 foot 6 inches were included in the 3rd class, leaving only those below 18 inches in the 4th class.

During the first year's observations Mr. Brandis found that the numbers of trees in the first three classes were very nearly equal in all but recently worked forests, and having thus obtained some idea of the proportion of the different classes, he proposed to himself the principle that, in any forests to be worked out, as many 1st class trees as would be replaced during the year by the growing stock of 2nd class trees, could and should be felled in that period.

Here we have the fundamental principle on which all working plans must *primâ facie* be based.

To estimate the number of 2nd class trees that would each year attain 1st class dimension, it was of course necessary to ascertain the rate of growth of teak, and Mr. Brandis was too cautious to accept without further proof the theory of annual rings representing one year's growth, and augmented his data by the measurement of a few trees, the age of which was known.

From the data at his disposal he constituted the following table :—

Girth in feet.	Age in years.
3 feet, ...	18
4 feet 6 inches, ...	39
6 feet, ...	62

On this table holding about the middle between data regarding the growth of teak obtained from Bombay and Jává, he decided to base his working plan until better data became available.

Mr. Brandis accordingly laid down that $\frac{1}{24}$th of the 1st class trees in each forest might annually be cut, and assumed that as the number of 4th class trees had been found largely to exceed those in the other classes, the forests would gradually improve under the proposed system of working, and become richer in teak than they were in 1856. This prognostic has so far proved true at least whenever the forests have been worked by direct Government Agency.

The plan of thus felling and extracting $\frac{1}{24}$th of all 1st class trees annually in each forest was open to practical objections, both with regard to labor and supervision. On account of this Mr. Brandis arranged the Pegu teak forests in six divisions,

each of which he worked in turn, girdling every 6th year ¼th of the 1st class trees in one division.

Mr. Brandis prepared next an estimate of the probable outturn of the Pegu forests. The linear surveys, it was calculated, covered an area of 30 square miles, and on these 2,423 1st class trees had been counted, or an average of about 80 trees per square mile. It was roughly estimated that the total area on which teak was scattered in Pegu amounted to 7,000 square miles, and a grand total of 5,85,000 first class trees was accepted. Thus in theory the outturn could have been fixed at 24,000 trees per annum; but Mr. Brandis clearly understood that many of the trees were growing in inaccessible localities, or for other reasons were of insufficient value to draw a purchaser, or to pay for their removal, and he consequently reduced the estimate to an average outturn of about 24,000 logs per annum.

Many alterations have since been made in the estimate, most of them by Mr. Brandis himself, or under his immediate supervision, as the whole of the forest area became better known and data on which to base calculations more plentiful, but on the whole it is wonderful what a good estimate Mr. Brandis managed to make of the resources of the Pegu forests within a year of his arrival in the country.

As regards the method of working the forests, Mr. Brandis had the following three systems to choose from:—

(1). The levying of a duty on every log brought from the forests, the felling of the trees being either free or restricted to the holders of a permit or grant.

(2). Selling the whole of the seasoned timber in a certain forest to the highest bidder.

(3). Bringing down the timber from the forests on account of Government, and disposing of it by periodical sales to the highest bidder.

Mr. Brandis recognized that the first system then actually in force in Burma, must cease, as it would inevitably result in the ruin and destruction of the forest. The choice was thus reduced, and either the second or third system had to be adopted. Mr. Brandis recognized that, provided the marking and girdling of the trees to be felled remained in the hands of the Forest Department, the second system was theoretically more correct than the third, as it encouraged private enterprise, and left the Forest Staff free to devote their time to general forest administration, and to the preservation, extension, and consolidation of the forests.

The prices, however, which were offered for the timber in the forests were so low, that it would not have been remunerative to sell. Moreover, whenever this mode of working had been introduced it had proved to be wasteful and unreliable. It was like skimming the cream of the milk, and private parties who had only a temporary interest in the forests were not likely to under-

take on an extensive scale works which had of necessity to be undertaken to thoroughly open out the forests, such as clearing of obstructions, blasting and road making, nor were they likely to pay the slightest attention to reproductive measures.

Considering all these points, Mr. Brandis arrived at the conclusion, that Government must show the way of working the forests on an improved and less wasteful system. He put, however, at the time, on record that once a permanent improvement in the working had been effected, the system of departmental working might safely be changed for one of selling the timber in the forests, provided reasonable prices were offered for the seasoned timber.

Mr. Brandis tried accordingly to work the forests on Government account by means of contractors, who were to fell the timber, drag it to the floating streams, and raft it to the sale depôts, but was at the outset met by new difficulties, for no local contractors were forthcoming. But again, thanks to his unflagging energy, he gained a victory, he imported contractors from Moulmein, selected energetic men in Pegu, or wherever he could find them, and succeeded in bringing some 13,000 logs to depôt during the very first season, though he was beset by all sorts of difficulties, as both his subordinates and his contractor were constantly trying to over-reach him. Government marks were erased, and some of the timber was sold, instead of being delivered at Rangoon, some first class Government logs were exchanged against an equal number of inferior logs belonging to private parties, and even near the Rangoon depôt the timber was not safe, whole rafts were detached during dark nights and borne away on the strong tides, were taken to hiding places amongst the numerous creeks and backwaters. In one of the Sittang forests, the contractors dragged a portion of the Government timber across the frontier, and afterwards imported it as foreign timber.

The forest subordinates and contractors and the population living on the banks of the floating streams had all combined, but their tricks were found out one by one, and their robberies were discovered and punished, and measures were invented and adopted to check and prevent the systematic cheating and theft. It took years to break up the combinations that were formed to rob Government, but the system introduced by Mr. Brandis in 1856 has since been elaborated, and the Pegu forests are now worked by contractors on Government account with the most satisfactory results.

For some years the second of the above-mentioned systems, the exploitation by private enterprise, was introduced in consequence of a strong agitation on the part of the leading merchants and under pressure from the Local Government, but the trial resulted in a failure with regard to finance as well as forest conservancy.

Mr. Brandis having thus created a system for the working of the Pegu forests, and proved, as far as proof was at that time possible, that its operation if faithfully carried out would not endanger their preservation, next proceeded to take steps for the preservation of the forests against other causes.

These measures he classified under the following heads :—

1. Protection against injurious and irregular felling.
2. Protection against jungle fires.
3. Protection against toungya or hill cultivation.
4. Protection against natural causes, such as creepers, parasites, shade of the trees, &c.

With the view of enforcing a proper protection of the forests, a set of 22 rules were published in October 1856. These rules provided for the appointment of a Superintendent of Forests, his Assistants, Gaungs, and Gaungways (watchers); they next prohibited or regulated cutting of teak, prohibited teak being injured, the setting of fire to teak timber standing or felled, prohibited the burning of toungyas on a spot on which more than 50 teak trees stand. They further provided for the reservation of certain tracts, protection of boundary marks, and the disposal of teak timber locally. Finally, it was ruled that all cases of infringing these rules should be tried by the Superintendent of Forests, either by personal enquiry, or on the record of enquiry made by a Forest Assistant. The only appeal lay to the Commissioner of Pegu.

With regard to jungle fires Mr. Brandis drew special attention to their injurious effects by—

(*a*), destroying or damaging timber seasoning in the forests;
(*b*), destroying or, at any rate, cutting back of seedlings and young trees;
(*c*), destroying large quantities of teak seed, and thereby retarding reproduction.

Mr. Brandis did, however, at that time (1856) not see his way towards preventing these jungle fires.

As formidable an enemy as the fire was found in the system of temporary cultivation universally practised by the hill tribes in Burma, as well as by the inhabitants of the plains when living near large forest areas.

This system, called "toungya" in Burma, consists in the clearing of the forest ground by axe and fire. The young trees, bamboos and other undergrowth are felled, and the larger trees are lopped and frequently killed by girdling. The vast quantity of timber and brushwood on the ground is then allowed to dry, and is ultimately fired. The few trees that may have escaped the axe are either killed, or at least permanently injured, during the fierce conflagration, in witness whereof hundreds of thousands of dead trees charred and with bare blackened branches may be found all over Burma. The area thus barbarously cleared is

sown and abandoned frequently after one, certainly after a few, year's crops have been obtained. As soon as left to nature, the land clothes itself with a dense growth of herbs and grasses, and for years till this growth gets less dense, and again makes place to arborivegetation, no teak seedlings can, unaided, spring up in and penetrate the dense jungle growth.

To prevent as far as possible the evil effects of toungya cultivation, it was ruled that no toungya should be cut on any spot which contained more than 50 teak trees large and small, and that dry standing trees and felled teak timber should be removed beyond the effects of toungya fires.

Mr. Brandis, moreover, recognized that the very system which till then destroyed teak forests might be utilized to produce them, or at least to ameliorate their character, and as early as 1856 an attempt was made in the Prome district to sow teak in regular rows, together with the rice scattered by the toungya cutters.

Twenty years afterwards this attempt had grown into a regular system, by which at present large areas are annually stocked with teak at a cost far below that of regular plantations.

Mr. Brandis also commenced at the very outset to wage war against the evil effects upon reproduction and growing stock caused by creepers, parasites and the shade of inferior trees, the timber of which he contemplated of introducing in the market so as to pay for the expense of removing them. He worked steadily in this direction, making experiments regarding the qualities of other wood, and publishing accounts thereof, and, though he himself did not succeed in his aim, he prepared the way for his successors, and at present considerable revenue is made from trees other than teak.

The last question before Mr. Brandis was—"What can be done for the improvement, extension, and consolidation of the forests?"

This he dealt with under the following heads :—

1. Pruning.
2. Plantations.
3. Nurseries in toungyas.
4. Thrown out seed in cleared portions of the forests.
5. Consolidation of the teak forests.

Pruning he considered at that period still impracticable, but experimental plantations were made in localities specially selected, forming the nucleus of extensive plantations in future years.

Mr. Brandis from the very beginning was an advocate of the system of planting in lines in preference to any other method, and of raising a mixed forest and not one of pure teak. The advantages of line planting are great, but future experience has shown that a distance of 6 by 6 feet more effectually checks the growth of young bamboos. The system of planting teak in toungyas has already been noted, as well as its further development.

The third method recommended by Mr. Brandis, that of throwing seed in the forest, has of late years been developed in-

to a markedly successful system. At present large areas over which the bamboo has flowered are cleared by fire, and cultivated before a jungle growth springs up, and this is the cheapest of all modes of cultivation. Mr. Brandis' successors have, especially as regards reproduction, faithfully proceeded on the lines sketched out by him as early as 1856, and the reproduction and welfare of the Pegu forests have been doubtlessly insured thereby.

Mr. Brandis found very soon that one of the chief obstacles of successful forest management was the scattered distribution of the teak trees, some 5,00,000 marketable trees being scattered over 7,000 square miles, and he very rightly at once urged the consolidation of the teak localities. His idea was to select the better tracts, and to convert them by protection, sowing and planting into localities containing mainly teak forests, so as to concentrate operations upon a smaller area, and thus to make the *constructions of roads and other works financially remunerative.*

This idea laid the basis to our present system of reserved forests, which would have made a still greater progress but for the unfortunate choice of the name "reserved forests." The constitution of State forests has been frequently proposed for the very well being of the surrounding population, but without result, as the authorities regarded them however unjustly as reserved, *withdrawn* from general usefulness.

Whilst thus reviewing Mr. Brandis' first year's work, the remarkable accuracy with which he at once hit on the leading principles of forest management in India must necessarily strike any reader. Changes have of course been made during the future development of forest administration, but the smallness of such changes, both in number and importance, that have taken place during the last 29 years is astonishing, and nothing shows more the wonderful care and the sound judgment with which Mr. Brandis worked from the very beginning.

During 1857 and up to July 1858 Mr. Brandis devoted his attention mainly to the administration of the Pegu forests situated between the Sittang and Irrawaddy on the principles already noted. He *enforced the forest rules, checked wanton destruction* of teak, and regulated or prohibited the formation of toungyas in teak localities, without causing dissatisfaction amongst the Karens and other forest tribes : he carried out considerable forest improvements, and started numerous small plantations. He found it at that time still impossible to induce villagers to sow teak in their toungyas, but he clearly foresaw the future importance of that method of restoring the forest, and states—"this, if the people can ever be brought to do it, is likely to become the most efficient mode of planting teak in this country."

Great improvements were also made during the time in the dragging, rafting and floating of the timber, and in July 1858 Mr. Brandis was able to leave the executive work of the Pegu

forests in the charge of the Assistant officers he had appointed, for a sufficient time to permit him to examine the Attaran forests.

The first result of this examination was a most interesting report, which we recommend to the study of every forest officer as one of the most instructive forest reports that has ever been written.

"*The teak forests of this Province,*" as Mr. Brandis points out, "are not extensive well defined tracts covered with one or a few species of trees, all useful and valuable or nearly so. Teak trees are found scattered in a forest, mainly consisting of trees of other kinds, all at present valueless, or nearly so, if compared with teak. Teak trees are either found *singly* scattered over a wide extent of ground, or they form isolated groups *of a few trees only;* or, lastly, teak is one of the *regular constituents* of the forest bearing a variable, but mostly small, proportion to the trees of other kinds.

"Localities where teak occurs are designated as *teak-producing* tracts. Between them there are others without any teak in them, and *frequently bearing a forest consisting of a class of trees altogether* different."

The teak-producing areas had, therefore, first to be found in the enormous forests which cover British Burma, and the two questions—

"(1), What is the area of teak-producing tracts in Tenasserim?" and (2), "What is the amount of teak on teak localities within a given area?" simple as they read, could only be solved at the cost of the most untiring labor.

Mr. Brandis had again recourse to linear surveys.

At the time Mr. Brandis' *Attaran* report was written, *the* valuation surveys actually covered an area of $42\frac{1}{2}$ square miles, which necessitated linear surveys of over 800 miles in length.

Mr. Brandis found that in the teak-producing forests in Attaran the teak tree formed about $\frac{1}{10}$th of the whole peuplement, and that the different age classes of teak bore the following average proportion per mille :—

1st class, ...	147
2nd ,, ...	100
3rd ,, ...	205
4th ,, ...	548
Total, ...	1000

These observations confirmed those made in the Pegu forests in 1856-57 as regards the general character of Burma teak forests. The Attaran report contains an extremely clear and useful description of the different varieties of teak-producing forests, and their classification noted down by Mr. Brandis in 1858 is still our standard, which may be accepted as another *proof of the wonderful power of accurate observation* which Mr. Brandis brought to bear on every detail of his work.

Neither time nor space permit us to follow the author of the

Attaran report further through his interesting description of the Attaran forests, nor can we at length trace the history of their administration under British rule which Mr. Brandis follows step by step.

The history exhibits a chain of vain attemps of a vacillating Government to protect forests against private exploitation, or to stand between the British speculator and his prey.

Mr. Brandis showed how all the many well intended conditions regarding manner of felling and measures to be adopted to ensure reproduction, and the future well being of the forests, with which the leases were plentifully seasoned, had in practice proved Utopian and meaningless.

He dispelled next the hope which had been entertained that all former wastefulness could be easily repaired by artificial cultivation, showing the enormous cost of extensive plantations in unhealthy localities rendered infinitely more difficult by the almost total absence of local labor.

Of the future of the Attaran forests Mr. Brandis took a somewhat gloomy view, in fact he thought that the best use that could be made of them would be to serve as a warning example to the rest of all India of the deplorable results of private management, and all he proposed was that the boundaries of leased forests should at once be clearly defined, that forests under leases and those still at the disposal of Government, should be separated, and in fact he initiated those stages by which all that could be saved of these once most valuable forests was saved, and prepared the way for the gradual resumption of the leased areas.

During the following years Mr. Brandis promulgated a revised and more comprehensive set of forest rules, which were sanctioned in December 1858. The control of the drift timber was placed in the hands of the department, a step which hereafter yielded not only handsome profits to Government, but secured honest traders from timber piracy and heavy losses of timber in transit; though at the time this step found strong opposition, for like most generally useful measures, this also affected the interests of a few.

Near the end of 1859-60 the clamour to permit private enterprise to exploit the teak forests became more pressing, and Mr. Brandis was somewhat disheartened with the general financial results of the first four years' working, which he considered at the time in no way adequate to the toil and anxiety the work had entailed. He expected more rapid returns from his arrangements, and took a much more gloomy view of the financial state of his operations than were justified by subsequent events.

This combination of circumstances led to the introduction of the permit system. Mr. Brandis introduced the system as cautiously as possible, and bound the permit holders by extremely rigid provisions; but in spite of all precautions it turned out to be another proof against the advisability of leav-

ing the exploitation of forests in the hands of speculators. An excellent set of rules were made to regulate the girdling of teak trees, and as only timber seasoned by the Forest Department was sold to the permit holders in the Pegu forests, this precaution was thought to dispose of any apprehension in that direction, but it was hereafter found that the very girdling operations were influenced by the agents of a large Rangoon firm. At the same time, however, when Mr. Brandis was pressed to yield with regard to the permit system he retained the most valuable of the Tharrawaddy forests, and introduced the system of loaning Government elephants to deserving contractors instead of making money advances, and this method forms now the ground work of all exploitation by direct Government agency, except in a few rare cases where large capital, content with reasonable profits, has stepped in, which not in need of advances of any kind rules the labour market.

Under the system of loaning elephants we have gradually created a class of men who have no choice, but must work for the Forest Department, which therefore entirely rules the market as regards conditions and rates. Both, however, are kept sufficiently liberal to make forest exploitation a very good livelihood, which sometimes may even lead to the accumulation of a small fortune. It may happen of course that elephants die and a man may lose the accumulation of years of labour, but in such cases the Forest Department is extremely liberal in its own and the contractor's interest, and a hard working and deserving man is never allowed to sink. The introduction of this method has given to the Forest Department both greater profits and more power than any other measure ever invented.

Mr. Brandis paid throughout these years the greatest attention to the improvement of the export lines from the forests, by clearing away obstructions and digging canals, amongst which the Schwaylay canal is the most important. This canal opened out a considerable forest district, and is still in use. All these improvements of course shortened the time it took for timber to reach the market from the forests, and lessened the chances of its being lost on the way.

The Rangoon depôt was formed into a central market place, at which periodical sales were held, and the disposal of timber under free grants for churches, chapels, kyoungs and schools was regulated.

The actual forest work of the whole of Pegu was thus concentrated in the Tharrawaddy Division, and it was therefore considered necessary by Mr. Brandis to remove the head quarters of the Forest Department from Rangoon into the vicinity of the forests. The old royal town of Myodwin was selected, and a large forest settlement was established. Mr. Brandis hoped that the Myodwin settlement would be the foundation of a permanent and growing location. In this he was disappointed, and hardly

any traces of it are left, thanks to the rapid expansion of forest work in Burma, which demanded the re-transfer of the head quarters to the centre of Government. Still the choice of head quarters for the work then in hand could not have fallen on a better place, and nothing helped more to get the work of the Tharrawaddy Division well in hand.

All this time the search for teak-producing areas and their examination was carried on with unflagging energy. In Pegu the forests west of the Irrawaddy were examined, and nearly 12 square miles of valuation surveys were made. The southern forest, including the valleys of the Pegu river, the Pounglin and the Hline, were searched through and through, and almost every teak locality was found and carefully examined and described. These forests are some of the most impenetrable and deadly in Burma, and must be known to appreciate the energy and application necessary for their thorough exploration to that extent as they ought to be appreciated.

The large teak areas on the Khaboung and the belts of teak forests on the eastern tributaries of the Sittang above the Thonkyeghat were most carefully explored, valued and described, as well as evergreen forests in the basins of Hpyoo, Koon and Bonee streams, in which teak-producing localities are scattered here and there. These forests were only visited by Karens and a few intrepid elephant hunters and dacoits. Their unhealthiness is so notorious, that the natives in the Shoay-gyeen district have a proverb—"He that awakens a sleeping tiger, the girl that loves a white man, and he that sleeps in Bonee forest, will come to grief and be ruined for life."

Still, Mr. Brandis' strong sense of duty made him live for weeks at a time in these forests, and by making friends of the original inhabitants, who throughout Burma still remember and love "Byandi thikin," he was able to explore these unknown forest areas with a degree of thoroughness which is perfectly astonishing.

In Tenasserim, the forests on the Beeling, Yoonzaleen and Upper Salween, the Lower Salween and Doomdamee, and the Thoongeen were explored during the same years, and a preliminary working plan was framed for them on very much the same principles as those originally adopted for the Pegu forest.

The forest area was also divided into six divisions, work to be carried on in one division at a time.

The annual outturn was estimated at 8,096 trees, divided amongst the divisions as follows :—

		Trees.
1st Division—	Beeling forests; probable annual outturn, ...	... 1,360
2nd ,,	Yoonzaleen and Upper Salween forests, do. do.,	1,463
	Carried over, ...	2,823

				Trees.
	Brought forward, ...			2,823
3rd Division—	Lower Salween and Doomdamee,	do.	do.,	1,426
4th, 5th & 6th "	Thoongeen,	do.	do.,	3,847
			Total, ...	8,096

The working plan was based on actual surveys of $20\frac{6}{10}$ square miles of valuation surveys, on which 83,499 teak trees were counted, including 21,532 of the 1st class ; the entire teak-producing area, excluding the upper portion of the Thoongeen above the Melgat being estimated at 552 square miles, and the rotation being fixed at 122 years.

The year 1861 was still a period of great anxiety to Mr. Brandis.

The expenditure, especially on the Pegu side, was very large, and the revenue still failed to be realized to the amount expected ; however, at the end of the year the prospects brightened, and Mr. Brandis was able to close his annual report with the words—"This is the first Annual Progress Report on the Pegu forests which I can close with a defined hope of good success at a period not far distant."

The results of the improved management of the Tenasserim forests became also apparent, the net revenue having risen in the last 3 years from Rs. 9,734 to Rs. 73,335.

The system of loaning elephants introduced in the previous year had been rapidly developed, and 73 animals had been made over to contractors, the waterways were uninterruptedly cleared of obstructions, the protection of timber in transit improved, and altogether the wheels of the department began to work more smoothly, so that Mr. Brandis expressed a hope to be able gradually to withdraw from executive work, a large share of which had till now rested on his shoulders. He personally conducted the extensive girdling operations during 1857 and 1858, and supervised in detail the introduction of working the Tharrawaddy forests by direct Government agency.

In 1860-61 Mr. Brandis introduced the sale of permits in Tenasserim by public auction, by which the rates realized per log were raised by Rs. 2 all round. Numerous forests were again explored and examined : in Pegu the forests on the Paddey and Choungoungyee, as well as the Swa, Myolah and other frontier forests and the whole of the Shoay-gyeen district ; and in Tenasserim all forests on the Beeling stream. Girdling operations were carried on under competent supervision.

During this and the following year an influential combination of merchants pressed again for the introduction of exploitation by private enterprise, and Mr. Brandis had a bad time of it. He saw clearly enough that the promises of the mercantile

firms in Rangoon to bring European energy and skill to bear upon the working of the forests were empty words, and that natives would be employed by the firms, where natives were employed by him, and he naturally preferred those he had selected and trained, and he had to defend his principles. During that time he was attacked from all sides.

The timber brought down by the Forest Department, of which as yet only a small proportion was the result of their own girdling, was criticised as wretched and worthless, and it was said that greater vigour would be displayed in the working of the forests by private agency.

All this must have been extremely galling to an officer who had sacrificed all his labour, all his energy, and who had toiled for 5 years to work the timber resources of the country on a system of strict conservancy; but still worse he was left to fight the battle alone, till in September 1861 the Governor General in Council recognized the position of the case and Mr. Brandis' special services. The outcome of a long correspondence, and several meetings, was that the Forest Department retained unconditionally the management of the exploitation of the Tharrawaddy forests, and that the rest of the Pegu forests were disposed of on 12 years' leases, specially prepared under the advice of the Advocate General. That Government, anxious for an immediate return from their forests, were heavy losers by these transactions financially, as well as from a forester's point of view, was proved by subsequent events.

The leases were no doubt entered into under Mr. Brandis' *régime*, but it is our pleasing duty to note here the following paragraph taken from a Government letter:—"I am to add that the Governor General in Council observes that great credit is due to that gentleman (Mr. Brandis) for the frank and hearty way in which the present papers show him to have acted in promoting the views of Government (opening the forests to private enterprise), though evidently opposed to his own ideas and disappointing to his hopes."

The rest of Mr. Brandis' direct administration of Burma flowed in quieter channels; means of exploitation were constantly improved, and export lines and waterways received the necessary attention. Girdling operations were combined with more and more detailed examinations of the forests, topographical surveys of the more important forest areas were begun, and improvements were introduced in every branch of the Department, which it would be impossible for us to follow up in detail.

Before leaving the Province Mr. Brandis framed a working plan for the second rotation from 1862-67. The total number of trees to be girdled in British Burma during that period amounted to 1,71,842.

Mr. Brandis left Burma on special duty on the 29th of November, 1862, and the permit holders no sooner felt the withdrawal of a strong hand than they began to agitate for new

concessions, which were clamoured for in an (for the time when the science of forest conservancy was not so generally understood) extremely smart letter, in which it was pointed out that forestry carried on under Mr. Brandis' rules, and on the principles laid down by him, would in practice be destructive of all hope of making the forests of the province a source of revenue to Government, or a source of supply for timber, and an element of wealth and prosperity to the country.

The fallacy of this statement has long been proved by events, but at the time it was the basis of a demand which amounted to nothing less than that the permit holders should be permitted to girdle themselves all marketable timber within the limits of the forest leased by them.

This demand, which of course would have insured rapid profits to the permit holders at the cost of the State, was supported by the officiating Conservator of Forests, and was submitted by the Local Government, who even moved thereto by the statement that the permit holders lost heavily by the exploitation of Government forests under the form of leases in force, which provided that all girdling was to be done by the Forest Department under strict rules and strict supervision. It cannot be gainsaid that the concentration of the timber works would have facilitated and cheapened them, but the introduction of this measure would have sealed the warrant for the destruction of the Pegu forests, and luckily our champion of forestry in Burma was to the fore, and pointing out the fallacies in the arguments brought forward, saved the Burma forests for the time being, and secured them from all future attacks from that quarter. This was a worthy conclusion to a brilliant struggle, for otherwise Mr. Brandis' successful administration in Burma can hardly be called. The province has to be grateful to Mr. Brandis for the introduction of many further improvements, but his direct connection with the administration of British Burma ceased here, and his work as Inspector General will be noted in a second chapter.

NOTES FROM REWAH.

"Big game shooting in India is not what it was some few years since." The remark is not mine, but was made in my hearing by a glutton, who had just returned from the districts, where with one other gun, he had been spending a two months' shooting trip, and had brought back with him a bag of 24 tigers and one panther. Poor fellow, he was regretting not having made up the complete quarter century of the former.

Generally speaking, I suppose my friend was right, though his luck belied him, for doubtless the spread of cultivation and general opening up of the country has in many places caused the complete disappearance of game, while almost every-

where, the introduction of breech-loaders, the reduction in the price of arms, and the transfer of muzzle-loaders into native hands, have curtailed the chances of making a big bag. There are very few places now in India where five tigers can be accounted for before breakfast or tiffin, as we read of in Gordon Cumming's "Wild Men and Wild Beasts," or where 15 or 20 tigers can be shot in the season by one or two guns as many of us know to have happened. In the country where G. C.'s exploits were performed, and in or about which I believe he killed over 100 tigers, *stripes* is now nearly as uncommon as a kangaroo, and in other parts of Central India, where formerly large bags were made, it is now a difficult and expensive matter to get a glimpse of the noble quarry.

All this is very right, proper and humanitarian I suppose, and a sign of civilization and progress in which we should all delight and consent without murmur. But life in the forest will be a very different matter to many men in the future, especially to those in whom the old Adam is still stronger than modern culture, when big game shooting has become the monopoly of the *big-wig* and the *globe trotter*, and when the dreary monotony of camp life can no longer be made more bearable by the chance of sport. A good many of us, I expect, owe no little of our forest topographical knowledge to the British love of pursuit, to sundry long stalks after sambur, or to following up wounded animals through places, which, in ordinary inspections, would have escaped our notice. Those among us who know what it is to pass the balmy months of April, May and June under canvas in the plains, also know how greatly the discomfort of this dreary time is alleviated by carrying out a successful little campaign against the big game, and can imagine how wearisome those long hot days would be, were all chance of such distraction to become a thing of the past. Let us be thankful, therefore, that we live in the present, where excitement may still be obtained by the expenditure of a little powder and shoe leather, and amusement can go hand in hand with our work.

The shooting of this part of India, as elsewhere, has suffered from the introduction of more accurate weapons. Every Thakur, whose battery formerly consisted of a few rusty matchlocks, now owns one or more breech or muzzle-loading rifles, while some of the better off sport the latest workmanship of Lancaster and Henry; and as they all have an innate love of shooting, which they indulge, provided it can be obtained without laborious exertion, and as they also have no respect for age or sex, they have managed, by incessant driving, to clear the forests of sambur, chítul, nilghai and pig in all but the most inaccessible tracts. A good sambur head is an impossibility in Rewah, while cheetul have nearly disappeared altogether. And that this is entirely owing to the improved

weapons of the people, I have no doubt, for the Thakurs themselves readily attribute the present scarcity of game to this cause. Many of them can remember when the forests were comparatively well stocked with the above animals, when bison were common, and elephants by no means uncommon, and this in places where now one may beat all day and not see anything but a few pig or a melancholy nilghai.

Bison are still to be found, but only in the rains, and with much labour, and a few elephants also wander up into the south-eastern forests from the Chota Nagpore direction, but they are very restless and uncertain in their visits. The last capture of them was made by the late Chief about 15 years since, when 30 were caught, most of which, I heard, subsequently died of neglect while in training.

The above remarks, however, do not, to the same extent, refer to the larger carnivera. Panthers certainly are not numerous, but tigers and bears can still be obtained in Rewah, and large bags made of them at the proper time of year. Perhaps some "Foresters" may be interested in reading the following notes of a fortnight's shooting enjoyed by the writer during the latter portion of April last year.

I had chosen for my hunting ground the neighbourhood of the Banás, a considerable river which flows into the Sôn, well supplied with water, and situated in a country covered with small forest-clad hills, the forest consisting principally of *Shorea robusta* and *Dendrocalamus stricta*. It was also a favorite part of the country for graziers, whose large herds of cattle frequented the small swampy valleys of the sarai forest during the hot months.

My shikaries preceded me, and, on my arrival in camp, were able to report a "kill" about 7 miles off. It was already 10 o'clock, so some breakfast having been packed up we set out at once. On reaching the place we were told of a second "kill" which had only lately occurred, and the shikaries felt sure of the tiger. He was supposed to be lying up in a V-shaped patch of jungle situated between two small river beds, in one of which were a few pools of water. My post had been chosen at the junction of the two streams, to command both, and the "hank" were put in to drive up to this point, the flanks being guarded by men on trees at intervals. I was eager to get this fellow as being the first of the season, and inclined to draw omens from the result for the rest of the trip. The drive came on with plenty of row, tom-toms and cholera horns, and my eyes were aching with the glare and fatigue of keeping them fixed on one spot. Nearer and nearer they came, and I was thinking it was quite time for the tiger to appear. Nearer and nearer, until they almost arrived at the point of junction and I gave him up. But just when the beaters were approaching the apex of the jungle, where the cover was very thick, out he charged

with that short deep "hough hough" so indicative of mischief, and went through them like chaff, knocking one man over in his rush, but fortunately doing no harm. He went clean away. We searched for him on an elephant but without success, and had to return to camp disappointed and tired.

That evening news came in of two "kills" at a place called Keolári, 12 miles off, so a *sowar* was sent on at once to make arrangements for the drive next day. On reaching Keolári I was told there were a tiger and tigress, and that the beat was a well known one and easy to arrange for. We started at 1 P.M., and found a *machan* made on the bank of the Banás, along which the beat was to take place. Some *stops* were posted to command a few ravines on the landward side, the river being considered a sufficient obstacle on the other. We sat and waited, feeling comfortably sure of getting a shot this time, and indulged in mental pictures of bagging both the tiger and his spouse. The beat was long and tedious and about three parts over, when one of the *stops* on my right gave signs of the tiger's presence. The tapping on the tree, however, which should have turned him down towards me, was succeeded by coughs, shouts and at last by some decidedly high flavoured Hindustani, as the *stop* tried each in turn to prevent the tigers from breaking. But they were not to be denied, and cleared out of the beat at a lobbing canter, I just catching a glimpse of them, through the bamboos, as they disappeared along the river bank behind me. We got down from the *machan* and made a rush for it, hoping to cut them off, but were not quick enough, for they crossed the river about 300 yards ahead, splashing through in a clumsy fashion, and offering no chance of a shot. One of the Thakurs, however, fired a gun at random loaded with slugs, which appeared to pepper the big chap behind, for he kicked up his heels and hurried his pace in a most undignified manner. The forest on the far side of the river was so extensive, that a second beat was deemed impracticable, and after an hour's search up and down some of the nearest ravines, we reluctantly turned homewards heartily disgusted with our bad luck. The place where the brutes turned up out of the drive was not more than 50 yards from my position.

This was very unsatisfactory, three buffs killed and three tigers escaped. I went to bed that night feeling after all that tiger shooting was dreadful rot, and that only an idiot would give it any attention.

But my ill luck was not quite played out yet. The next morning I was to meet Baharat Singh, the *Talukdar* of Marwas, a thorough sportsman and good fellow, who had promised to assist me in his district, which commenced from the other bank of the river. I was bringing him a double barrel breech-loader he had asked me to purchase for him, and which I had picked up a great bargain at Allahabad. Well, early on the morrow, he

sent word across of a kill, and that arrangements had been made for a drive. I crossed the river at 12 o'clock and met him. He was delighted with the rifle, and told me there were no end of tigers in the neighbourhood. This was good news, my hopes began to revive, and I felt certain of getting the tiger that day. Baharat Singh, to make things perfect, placed the *stops* himself, putting his brother Pokur Singh, armed with the new rifle in the most important place, which indeed was the only place where the tiger was likely to break away, and he then went off to supervise the drive himself.

I was beautifully placed, could shoot right, left, and in front, and felt quite capable of hitting the tiger in the eye when he appeared, as of course he presently would. I was thinking whether he was likely to come over the rising ground on my right and offer me a head shot, or whether it would be more convenient to shoot him through the shoulder as he slouched past my front, when all these dreamy schemes were roughly dispelled by a shot from my right, where I knew Pokur Singh had been posted. My usual luck of course. Although the chances were 10 to 1 the tiger would come straight up to my tree, he had, on this occasion, gone towards P. S., and that worthy states, would insist on going past him in spite of taps, coughs, &c., and that he only fired when he saw he would not be turned in my direction. Oh! Pokur Singh! may you be forgiven. Was not the real state of the case that, having a new rifle in your hands, and finding the tiger coming towards you, offering a beautiful mark, you could not resist the temptation, but forgetting all about the unfortunate *Sahib* who had come out a hundred miles for this chance, you blazed away and shot the tiger so neatly, that we found him lying dead within 80 yards of your tree. That in my opinion is the true account of what happened, and I am inclined to think that some roughish language which passed between B. S. and his brother on the subject, showed that his suspicions jumped with mine. The tiger was a moderately big one, measuring 9 feet 5 inches as he lay.

Two kills being reported at Kota, 12 miles off, we marched next morning, taking breakfast with us, and arrived at the place where the buffs had been killed, before the trackers had come in from their morning work. Here we had a long hot wait under the trees, which, being small coppiced sarai, offered very little protection from the sun. But it gave one an opportunity of having breakfast and hearing all particulars regarding the tigers, kills, and probable line of beat. Presently, the trackers arrived with news of three tigers, and that all three had been marked down as having retired to a small hill about half a mile from where we were then sitting.

Arrangements were speedily made for the drive, my position being taken on the bank of a stream which flowed between

the tiger's hill and another, and which they would be obliged to cross during the drive. The hill in front of me was very rocky, and bare of vegetation half way up, but densely clothed with sarai coppice at its base. The drive commenced on the far side of this hill, and long before it had reached the top, I saw all three tigers climb over the rocks in front of me, following one another in Indian file,, and enter the thick forest on the lower slopes of the hill. On came the beat, and on came the tigers until they arrived at the foot of the hill on the opposite side of the stream, and here they squatted, evidently afraid to face the open space between them and the hill behind me. Presently, as the drive pressed them, they attempted to break back, but were fortunately prevented, the Baigarhs of this part being very efficient beaters. The tom-tomming was re-doubled, the most excruciating corkscrew twisted notes were expelled from the cholera horns, and some blank cartridge was fired, which at last had the desired effect. One of the tigers broke cover and rushed across the open a little to my left, *howking* loudly, and giving me a nice side shot, which I could see took effect but did not stop him. A second one also broke, but on hearing my shot slunk along the nala bank on the far side. I knocked him over with the left barrel, but he was up at once and out of sight before I could give him the contents of the second rifle. No. 3 then broke back through the beaters and got away.

I had taken the precaution of placing some men behind me in case an animal went away wounded, and from one of these we learnt that the tiger first fired at had stopped under a tree a little distance from his post. On going there with an elephant we found him dead ; the ball had taken him fairly behind the shoulder. The other fellow was also badly wounded, as was evident from the blood drops which were plentifully besprinkled and very obvious on the bright new leaves of the sarai, and eventually, after half an hour's careful tracking, which was rendered an easy business owing to the line travelling through very open forest, he was marked down by the Baigarhs as having entered a stony ravine with steep banks. Here we got off the elephant and climbed the ravine, keeping a sharp look out down below and opposite to us, and presently the tiger was spotted lying under an overhanging rock on the far side of the ravine. He was quite 80 yards off, and partially concealed by an aoula bush, and I could only make out his head, but fired, hoping that should I miss his nob, my ball would take effect elsewhere. The result was startling, for immediately after the report, the tiger fired at rushed up the ravine, while a second one that had been quite unseen charged out straight in front, taking us so unawares, that had it not been for the steep sides of the ravine, he would certainly have succeeded in interviewing us at close quarters, for he managed to get right under us before I pulled myself together and floored him

with a shot through the back, which effectually disabled him. This fellow turned out to be the wounded one, and the other must have been No. 3 which broke back through the beat and rejoined his comrade at a rendezvous well known to them, for on crossing the ravine we found the tigers had been lying at the mouth of a spacious cave, which from old and new marks was evidently one of their general resorts. My first shot had been a miss, as the mark of the bullet was visible on a rock close to where the tiger had been lying, and as no further drive was considered feasible that day, we padded the two animals shot and rode into camp. They turned out to be both tigers, measuring 9 feet 7 inches and 9 feet 5½ inches respectively.

The next day, there being no kills reported, arrangements were made to beat a range of hills for sambur. As regards the latter the drive proved a blank, but three bears broke close to where my horse and the elephant were waiting, one of them coming so near the former, that according to the syce and mahout he lashed out and gave the bear a sounding kick in the face. It was a very hot day, and the bears not being likely to go far, we reformed the beaters and posted ourselves on ahead. About the middle of the beat there was a loud cry of *bhálu, bhálu*, showing us the game was on foot, and soon afterwards two of them broke in front of Baharat Singh and myself. B. S. knocked his over dead, but although I had a close head shot at the other I failed to drop him, and bruin turned short round and disappeared in the thick sarai coppice before I could put in my second. When the beat came up, we heard that, early in the drive, one of the bears had broken back and mauled a beater who had pluckily, but rather foolishly, tried to turn him with a *láthi*. On examination, we found that the small bone of the wrist was broken, and there was a deep tooth mark in the forearm. The man behaved very well, and after being washed, bandaged and fortified with some Glenlivet, which I fortunately had out with me, was sent into camp to be further treated on our return.

Enquiries had elicited that the man had been attacked before the shooting commenced, and therefore by the unwounded bear. The one fired at by me had made his way to a small detached hill, which we now arranged to drive, and as the beaters were a bit unsteady, several of B. S.'s men, armed with matchlocks and *talwars*, were distributed among them. Bruin was there all right, and after a bit, not liking the infernal din in his rear, came out in my direction looking rather sick and carrying his head low. I let him come up to the rock on which I was standing, and then dropped him with a ball through the shoulders. My first shot, fired from a ·500 express, had made a large but quite superficial wound on the back of his neck. On return to camp, we made a rough splint for the wounded beater, and gave

him a bottle of carbolic oil for lotion, and this season had the satisfaction of finding that the treatment had proved successful.

Next morning, I went round to visit the buffs that had been tied up in the neighbourhood, but found them all untouched. On coming into camp however, we received news that a cow had been killed by a tigress some five miles off. Her ladyship was a nasty tempered animal by report, and although no man-eater, had killed two and wounded several villagers in a most unprovoked manner during the past year. She was well known to the graziers also, and voted a nuisance by everyone. The beat for her was arranged along a small stream, on one bank of which B. S. and I posted ourselves, placing *stops* along the other. The drive commenced, and almost immediately afterwards I saw the tigress a long way ahead slinking down the nala among the grass. She seemed a little beast not bigger than a panther, and she soon turned into the jungle and disappeared until a few yards in front of my *machan*, when instead of coming straight on, she turned off up the bank in the most provoking way, offering no shot until she arrived quite at the top, when, for an instant, she showed herself through some light bushes. There was only time for a very hurried shot, which however, the *stops* on the other side of the stream declared, took effect. But on climbing the bank we found she had disappeared, and although we traced her for several hundred yards, we found no blood marks, so, as tracking became impossible owing to the hard rocky soil, and I had all along the strongest doubts of my shot having hit her, we gave it up as a bad job. And herein we made a mistake, for her remains were found a few days afterwards within two miles of the place where she had been shot, and had we persevered in our search I should probably have got her skin, which, under the circumstances, proved useless. She had been shot in the stomach.

On getting back to camp we heard that a tiger had been seen drinking at a stream some miles off, and that he had afterwards gone into a small ravine which Baharat Singh knew and thought was well worth beating, so we all had something to eat and started away. A long hot tramp, especially for the beaters, poor chaps, who had already had rather a towelling in the morning.

The ravine was beaten and out came the tiger, but not near me or B. S., and, as the latter was eager for another drive, as he felt tolerably sure where the tiger had gone, we started for a patch of green sarai jungle about a mile off, and reached it just as it was growing dusk. There was no time for any thing but to cut a few branches and place them in front and around us as a screen, and just as we had arranged ourselves behind these and a clump of bamboos, the tom-toms commenced. I forgot to say we were on the top of a very low hill or rise. Presently, B. S. touched me on the shoulder and pointed

down the side of the hill, where I soon made out the tiger trying to slink away. The light by this time had become very bad, but he was not more than 50 yards distant, so waiting until he cleared a clump of bamboos I drew a bead on his shoulder and fired. But my ball, as I afterwards found out, missed, having struck an intervening bamboo, and immediately after the shot, the brute charged straight at us and came on with such a rush, there was no time for anything but blazing away in his face when he seemed actually upon us. The flash of our rifles fortunately turned him slightly, but so slightly that, instead of coming through us as I felt certain he would, he only brushed away some of the boughs that had been piled up around us, and he left us, for the moment, so startled with our narrow escape that we let him go without further shooting.

My belief is that the charge in our direction was quite an accident, for the tiger gave no tongue, and would scarcely have been turned from his course had he seen us and charged intentionally. My ball probably ricochéd from the bamboo and struck the ground in his front, thus turning him nearly at right angles to his original line, and bringing him *vis-à-vis* with us. It was also fortunate, I think, that neither of our second shots touched him, for had we only wounded him at such close quarters, the consequences would probably have been a severe mauling for one or both of us. When the beaters came up, they told us a second tiger had broken back through the drive. Altogether a most unsatisfactory day, but one that might have been worse.

The following day we had another beat for a tiger considered a certainty, but he broke through the *stops* and got off.

Then came two blank days, and then one on which I bagged a bear. Poor old fellow, we intercepted him before daylight on his return home from mowha grazing, and shot him as he scaled the rocks below us. He came on for a few feet higher, and then, relaxing his hold, rolled right down the hill, a pretty high one, and was found dead at the bottom.

And then came news, for a second time, of a kill at Nawria, 20 miles down the river, where I had sent a man at the commencement of the trip, so I parted from Baharat Singh and marched northwards, arriving at Nawria on the morning of the second day, where I heard of a third kill, and was informed, as usual, of the monstrous proportions of this particular beefeater.

A ravine running up from the Banás was to be driven, so I took up a position on a small mound nicely situated in the middle and near the head of the ravine. The tiger was bound to pass me either on the right or left, as the sides of the ravine were steep and lined with *stops*, who had been plentifully supplied with stones. It was a terribly long hot beat, but not uninteresting. First of all some jungle fowl came whizzing by, then a peacock, followed presently by a lumbering old bear, and

then came, sneaking up so close to us that we might almost have caught her with the hand, a prettily marked civet cat, with long sharp mobile nose, fierce little eyes and ears ever on the alert. And then came a lull, and then, just as I was cramming a sandwich into my mouth, for it was 12 o'clock, and I had eaten no breakfast, out slouched the tiger, looking, oh so lazy, hot and disgusted with the disturbance going on behind him. On he rolled up to the foot of the little eminence on which I was perched, when thinking he required a rest before proceeding farther, he deliberately sat down on his *hunkers* behind a small bush, and turned his head back in the direction of the beat. The position was good, all except the intervening bush, but I had a 12 bore in my hand, so taking a leisurely aim at his shoulder, I fired, and had the pleasure of seeing him roll over like a rabbit. By a curious fluke, my second shot struck him in the same spot as the first one. He died without grunt or moan, a short tailed very heavy tiger 9 feet 6 inches long.

Shortly after this, we heard a *stop* on the right tapping furiously, and thought there might be another tiger in the beat of which we knew nothing. The tapping was soon repeated on the left, and this was followed by a loud clattering, as a herd of spotted deer trotted up the ravine. Thinking that perhaps these had been the cause of the tapping, and it being my last day's shooting, I fired as they passed, dropping a young stag and wounding a better one, which we afterwards retrieved. However there was a second tiger in the beat after all, but the beast squatted on hearing all this firing, and when the beaters reached her, would certainly have done damage, but that fortunately they were preceded by a dog at which she made a vicious but ineffective rush, thus giving the men time to clear out of the nala, down which she at once skedaddled and so on out of the beat.

My time was now up. I was obliged to return at once to head-quarters, or I dare say I might have been still more successful. As it was, during the 10 or 12 days I was actually shooting, we had bagged 5 tigers, 3 bears and 2 spotted deer, and had done this in spite of more than a fair share of ill-luck or bad management.

J. M.

THE PAPER MULBERRY.

(*Broussonetia papyrifera*).

THIS interesting tree is hardly known beyond the limits of Botanical Gardens in India,* and as its bark produces one of the

* A specimen of *B. papyrifera* in the Forest School compound, Dehra, from seed sown in 1882 is now 1 foot 4½ inches in girth at 4 feet from the ground, and 25 feet 9 inches high.—[ED.]

strongest papers known, these few notes may draw the attention of arboriculturists to it. It thrives exceedingly well in the Botanical Gardens at Sahárànpur, and will no doubt thrive in most parts of India. It is easily raised from seed sown in spring, or by cuttings made in the cold season, and plants raised in either manner will produce marketable fibre in their second year. This tree when full grown stands about 30 feet high, and when cultivated for its fibre is never allowed to grow into a tree, but is cultivated much in the same way as we grow osiers. The following extract from the "Treasury of Botany" illustrates the method of cultivation and manufacture of the paper adopted in Japan and South Sea Islands.

"The Japanese cultivate this plant very much in the same way that we grow osiers, and they use only the young shoots for the manufacture of paper; these are cut into conveniently sized pieces, and boiled until the bark separates readily from the wood, when it is peeled off and dried for future use. To convert this bark into paper, they proceed in the following manner:—The dried bark is first moistened by soaking for a few hours in water, all superfluous matter is then removed by scraping with a knife, after which the bark is boiled in a ley of wood-ashes until its fibres are thoroughly separated, when it is reduced to a pulp by beating with wooden batons; this pulp is then mixed with mucilage and spread upon frames made of rushes. The paper thus made is of a whity-brown colour, and very strong: it is in common use in Japan. Instead of paper the natives of the South Sea Islands manufacture from this bark an exceedingly tough cloth, called *tapa* or *kapa* cloth, which they commonly use for clothing, either plain or printed, and dyed of various colours. This cloth is principally made by the women, who adopt the following method of manufacture:—The bark is first softened by being soaked in water for a considerable length of time: it is then placed upon a log of wood and beaten out with a baton until it is of the requisite degree of fineness; the baton is made of very hard wood, and has four flat sides, each of which is sharply ribbed. Two or four women usually work together, and as they keep time in beating, the noise they make is loud and musical. In some islands, however, another and inferior method is adopted, the bark being placed upon a flat board, and scraped with different kinds of sharp-edged shells while kept constantly wet. By employing mucilage obtained from the arrow-root, the natives join pieces of cloth together, and Admiral Sir Everard Home states that the King of Tongataboo (one of the friendly islands) had a piece made which was two miles long and 120 feet wide." This extract shows that the fibre is a very useful material, and if a plentiful supply of it were always obtainable, it is hard to say where an end of its usefulness might be found.

W. G.

III. Notes, Queries and Extracts.

A Great Discovery in Fruit Culture.—Pure food makes pure blood, and no food is so pure as fruit. An abundance of fruit ensures the health and prosperity of the people. No crop is so rich and productive. Few objects in nature are so beautiful as a fine tree adorned with blossoms in spring, or laden with fruit in autumn. Our troubles have been that the proper culture of fruit has not been understood, and that our gardens and orchards have therefore been uncertain and often unproductive. The science of Fruit Culture has not existed. Its discovery, just now, we consider one of the most important events of this century of great discoveries—really more important than the discoveries of steam and electricity. The new method of fruit culture, or more probably a revival of an old one known and practised perhaps for ages in China and Japan, comes to us from North Wales in a letter by Mr. E. K. Kynaston, and an illustrated pamphlet by "Head Gardener," the pseudonym of Mr. Kynaston, entitled, "Out-door Fruit for the Million. How to grow it in large and continuous quantity by simple and inexpensive means," with the motto—"Who loves not fruit, ripe glorious fruit—a priceless boon from the great Creator's hand?"

Mr. Kynaston, who modestly calls himself "Head Gardener," appears to be a gentleman of education and property, who has devoted himself to fruit culture with the enthusiasm of a discoverer and benefactor. If the man who makes two blades of grass grow where one grew before is a benefactor, what shall we say of Mr. Kynaston?

At the opening of his pamphlet Mr. Kynaston tells us that after long years of practical horticultural experience he succeeded in growing English fruits in unprecedented quantities, continuously, by simple, inexpensive means. He was always his own head-gardener. Living on property of his own, after some experience abroad, he planted more than twenty years ago a choice and varied selection of fruit trees. He says:—

"In about three years' time the young trees commenced bearing, and have borne from that period annually increasing crops, until at last the fruit hung for thickness like leaves upon the trees; and shelf after shelf, closet after closet, room after room had to be devoted to its storage and preservation.

"In the autumn of 1875, the garden being as usual loaded almost to its utmost, the writer hand-picked himself three trees to ascertain the exact count of fruit upon each. The tree (a

dessert pear of excellent flavour), nailed to a wall 7 feet high, yielded 704 marketable pears. The second tree, also a pear, somewhat larger than the first, yielded a count of 748, and as the fruit was of the preserving order—very large and solid—the crop filled four huge baskets, each one a load sufficient for an average man to lift and carry. From the third tree, an espalier apple, of very moderate size, 700 choice russets were gathered, leaving some seven or eight dozen behind as being below a regular marketable standard. Thus for three young and comparatively small trees, no less than 2,152 count of good sound keeping fruit was gathered, and as there were some 25 distinct varieties of pear trees in the garden—all fairly well loaded according to their respective sizes and weight of fruit—for instance, one of them of no great size, whose fruit had easily been forced up to a pound in weight, yielded upwards of 400—the general crop from this source alone may in some degree be imagined—in fact, the hand-picking of the fruit, together with its storage and disbursement, formed about the heaviest as well as the most pleasurable job connected with the garden.

"The fruit grown consisted of Apples (good dessert sorts, Pears, choice varieties, such as Maria Louise, Duchesse, Beurré Diel, Muscatel, Jargonelle, &c., Peaches, the trees bearing immensely—the count of good well-ripened fruit going up to 300 on a single tree, Apricots, Plums of several varieties—the New Orleans kind cropping extra largely, and the Magnum Bonum going up to a quarter of a pound in weight, Melons, Grapes (out-door sweet water), Strawberries, Currants and Gooseberries, black and white Grapes, with other tender fruit, were grown under glass with similar success, and weight of fruit, but this kind being expensive to grow is not, nor probably ever will be, for the million in this country.

"Now none of this splendid fruit ever went to market—it was grown purely for the love of its growth, use and distribution—besides the *ad libitum* supply for his own table—(which was supplied as tables seldom are) "Head-gardener" sent weekly baskets for the greater part of each year to his own relations, who having more than they could consume, distributed in their turn, and his friends and neighbours were likewise liberally remembered. One lady not long ago told him that she felt sure that her aged mother's days had been lengthened by the constant supplies of delicious fruit sent her. But what surprised people more even than the unprecedented yield of fruit was the following circumstance, viz., that whenever blight (so-called) destroyed or partially destroyed (which it too often did) the fruit prospects of the neighbourhood and country at large, "Head-gardener's" trees were never once affected by it. Blight or no blight, fruit to almost any extent was always to be found in his garden.

"Not long ago, a near relative of mine, possessing a fine

large standard apple tree of a good dessert kind, non-bearing, begged me as a favour to take it in hand, and the following autumn the tree was so loaded with fruit that a cart (baskets being of little use), had to be backed up under it to convey away the crop—so that even half-a-dozen good trees well looked after, would constitute a respectable orchard, and become certain and valuable property."

In another case he restored an old, worn out, neglected orchard to such vigorous bearing that the trees had to be propped up to keep them from breaking down with the weight of fruit. Trees that had not borne fruit for fifteen years were restored to vigorous bearing in a single season.

A man who has done such work may well magnify his work. Mr. Kynaston says :—

"As fruit is one of nature's best medicines—being at one and the same time cooling, digestive, and health-giving—and is besides the direct alternative to the white bread, tough meat (as a rule) and other astringent food, which we daily and so largely partake of—its moderate constant use is therefore absolutely essential to our well and perfect being—consequently its proper cultivation would greatly add to our individual and national interests. Now I have found fruit easy enough to grow in marvellous quantity by the simple and inexpensive means which I have adopted: my plan being, after thinning out small poor fruit, to let the trees then bear to their very utmost, and the sure sign that they were equal to their work was, because they never dropped their fruit."

Mr. Kynaston says he has never exhibited or "paragraphed" his pears, nor sought for any publicity; but having proved his work, he thinks it his duty to teach his method to the public.

What that method is we will show as clearly and briefly as we can.

A fruit tree, Mr. Kynaston says, has three kinds of roots, each with its own special function.

1. A tap root, going down perpendicularly from the trunk, simply to give a firm support to the tree. This should not be meddled with.

2. Long roots, corresponding to the branches of the tree, which supply the nutriment for woody growth. These should be pruned to limit and regulate such growth.

3. Flower and fruit feeding roots, which are small and thickly clustered round the trunk of the tree. These are to be cultivated and nourished that they may supply the fruit-making materials.

To restore a fruitless tree to its proper function, prune away surplus wood among the branches, but leave enough for fruit. This may be best done in autumn. In the spring, when the tree is about to blossom, dig a trench about it from four to six feet from the trunk—according to the size—and about a foot in

depth, and cut off the spreading roots. If the tree be small this can be done with a sharp spade. This will check the growth of wood and allow the life force of the tree to be chiefly expended upon its fruit.

The next point is to feed the starving fruit rootlets. As soon as the blossoms appear, do what the gardener in the parable of *the barren fig-tree proposed to do—dig* about and dung it. Carefully open and loosen the soil within a yard of the trunk, and moisten it daily with liquid manure, a bucketful to a small tree, and two or three to larger ones—half common manure and half water; and, Mr. Kynaston insists, all sewage and suds from the house, which, as the waste matter of human, fruit-eating creatures, is just the material needed by the tree to manufacture into fresh fruits. Guano also does well, and the sweepings of the hen-house. The great point is to provide the matter of which fruit is made *at the right time, in the right place, and in sufficient quantity.*

The right time is from the flower to the full grown fruit.

The right place is near the trunk of the tree where the fruit rootlets thickly cluster.

The right quantity is *enough.* The roots will not absorb more than they need. What remains will be good for next year. The trees will be none the worse for a winter crop of cabbages or other hardy plants.

Trees may be cleansed from parasites by washing with soda or lime. But a healthy, vigorous tree takes care of itself. It is *the weak that suffer from parasites.*

We give Mr. Kynaston's facts and his method. We have no doubt that the facts are true; and no doubt that the adoption of his method everywhere would add millions to the wealth, and greatly increase the health of the English people.

In one case where an old, neglected, unbearing orchard, had become a mere thicket of tangled branches, Mr. Kynaston—or "Head-gardener" as he likes to be called—took it in hand. It was a tough job, but "next year every tree responded grandly to the call of good cultivation—the trees cropping, in many in*stances so heavily, that props* had to be placed under several of their branches, to prevent the weight of fruit from breaking them down—and the year after the crop was still heavier."

Fruit trees, Mr. Kynaston insists, cannot be injured by his process, and also cannot fail to bear abundant fruit. Trees which had not borne fruit for fifteen years, but only "made wood," have been perfectly covered with fruit in a single season.

Such being the fact, what is to hinder the whole country being covered with fruit, and every town supplied cheaply and abundantly with the best, most delicious, and healthiest food?

Speaking of the advantage which discoveries may be to Agriculture, Mr. Kynaston says:—

"People living in London can form but a poor idea of the

distress (ever-increasing) that exists in agricultural districts; both landlords and tenants are everywhere in large numbers, being either hopelessly ruined or else miserably reduced in circumstances. It really appears as if one section of the people were about to be starved, in order that the other might have cheaper food. We have, I fear, departed from the safe and happy medium course, and ventured on extremes, which always, as a rule, end badly."

Mr. W. S. Roberts writes:—"I am well acquainted with Bala, and its many drawbacks with respect to climate, frequent rains, bath springs, and cold piercing winds: but I can bear testimony to Mr. Kynaston's most wonderful success. Trees and shrubs which before scarcely bore any fruit are now with bended boughs and branches overloaded with fruit. Apple, plum, currant, and gooseberry trees all speak: If you but cultivate us aright, we will produce abundance and plenty for all. No doubt *many thousands of pounds are lost annually through a lack of* this knowledge of how to cultivate our fruit trees. Doctors of the highest standing have declared that the juice of ripe fruit is an antidote in cases of fever."—*Herald of Health.*

INTERNATIONAL FORESTRY EXHIBITION, EDINBURGH.—Tuesday last was a great day in Edinburgh, and the whole populace—and the visitors too for the matter of that—seemed for the moment to have laid aside their normal pursuits, and to have suddenly become embued with the idea that the most burning question of the hour was "Forestry," and the only subject of conversation of interest to anybody that of trees, timber, and arboriculture. At the railway stations, hotels, and even in the streets, one had only to keep his ears open to know that the "Forestry Exhibition" was the uppermost thought in the minds of everybody, and this could not be regarded but as a happy augury for the success of the important undertaking in hand.

The grounds of Donaldson's Hospital, in which (by kind permission of the governors) the Forestry Exhibition buildings are placed, are situated in the West End of Edinburgh, about a *quarter of an hour's walk from the western end of Princes Street,* and are easily accessible by tram-cars and omnibuses.

The building, which has been constructed by Messrs. W. Beattie & Sons, builders and timber merchants, Edinburgh, from the designs of Mr. R. Morham, City Architect, at a cost of £5,000, consists of a great nave 600 feet in length by 50 in breadth, intersected in the centre and near each end by transepts 138 feet long and 50 broad. Over the intersection of the central transept with the great nave is a lofty dome, surmounted by a flagstaff, and at the corresponding intersections of the eastern and western transepts there are octagonal pavilions. The dome and pavilions diversify the outline of the huge building, add dignity, and secure effect in interior disposition, while further

variety is given by the transepts, whose southern front is relieved by ornamental pillars and steps leading down to the soft fresh turf of the lawn. Light is admitted to the building by means of lying lights along the upper half of the roof, side windows in the pavilions, and in the gables of the nave and transepts. Ventilation is secured by openings along the ridge. At right angles to the northern divisions of the transepts, and opening from them by means of handsome arcading, are three large annexes, the central one 200 feet in length by 31 in width, and the eastern and western 150 feet long and 31 wide. The building is appropriately composed of wood, and the roof is covered with Gray's patent felt. At the north side and between the transepts are two refreshment-rooms, each 100 feet in length by 20 in breadth, and alongside these are kitchens built of brick with corrugated iron roofing. Entrance to the main building is by means of a spacious corridor, which extends from the westernmost gate of the hospital ground to the west gable of the nave. This corridor is approached by a handsome granolithic pavement laid down gratuitously by Messrs. Stuart and Co., the patentees. A short flight of steps leads from the pavement to a picturesque Swiss porch, with triple arcading, projecting roof, and carved eaves. The porch opens into the corridor, which is 25 feet in breadth and 160 feet in length, when a turn is taken to the right, and the nave entered by means of a double flight of steps. On the left of the corridor is a series of rooms for the post and telegraph offices, left luggage, railway and police offices, &c.

In the interior the building is light, airy, and imposing. The perspective of the nave is attractive, the roof being supported by circular ribbed couplings, which have been painted a pretty light blue. Additional effect is secured by the fact that the northern divisions of the transepts are at a higher level than the nave, and are approached by a short flight of steps set off with ornamental railings.

Speaking generally, the exhibits are displayed on stalls 10 feet wide, fixed against the walls of the nave and transepts, with a central space fitted with tables or separate stalls, leaving a wide promenade on either side. What may be called the wall space in the nave and transepts has been reserved for Government or official collections from foreign countries, the central stalls and the annexes being devoted to private exhibitors. The whole building is illuminated at night by the electric light, fitted up by the Anglo-American Brush Electric Light Corporation. The wires are led along the roof on either side, and the arc lamps number 70, with larger ones for the dome and pavilions. The annexes, refreshment-rooms, and corridors are lighted by means of incandescent lamps some 150 in number.

We suppose there is some unknown power which designedly prevents exhibitions of every sort of kind from being in anything like an advanced state of preparation by the day announc-

ed for their opening, and the Forestry Exhibition is certainly no exception to the rule. On every side there are blank spaces and signs of unreadiness, the effect of which is intensified by the fact that the whole of the two transepts at the upper end of the building, reserved for the Japanese section, are at present entirely unoccupied. However, this will all doubtless soon be remedied, and in the meanwhile we propose to give our readers a few notes of the exhibits which are in their places, confining ourselves strictly to those more or less connected with the trades represented by this *Journal.*

Commencing on the right, as we enter the main building, the first exhibit to meet the eye is a small collection of the woods used in the Royal Arsenal at Woolwich, neatly put together in frames, exhibited by Her Majesty's Secretary of State for War. Almost immediately adjoining this—the places of honour being very properly given to our own Government departments—is the very creditable display made by the Commissioners of Her Majesty's Woods and Forests, which reflects great credit on all connected; and Sir James Campbell, at Dean Forest, the Hon. G. Lascelles, at the New Forest, and Mr. F. Simmonds, at Windsor, have evidently spared neither time nor trouble in making their respective exhibits worthy of the important Government department to which they belong. A word of praise is also due to Sir Henry Loch, who, during his short tenure of office, did all in his power to facilitate the preparation of a good exhibit. The "Woods and Forests" exhibit consists generally of specimens of trees grown in the respective forests, with samples of tools used, photographs, plans, and a few arboreal curiosities. From Dean Forest we noticed a very fine oak plank, the tree from which it was cut being stated to have taken 200 years to arrive at maturity, a splendid specimen of oak, and a very useful table, showing the annual increase of circumference in some oaks during a long period of years. The New Forest sends some good specimens of timber, and a number of good photographs of the grand and old historic trees of that locality, besides a good collection of the tools now in use there. We noticed, amongst others, a curious excrescence of bark of an unusually massive nature, which had grown round the branch of an oak. The Windsor Park display is a remarkably good one, and comprises a very complete collection of foresters' tools, some of which are not generally used elsewhere. We notice a very useful tool for extracting roots from drains, in which position they are often very troublesome and destructive, and also a large root of elm taken out by the tool. The workmen's houses on the Windsor estate, as might be expected on a property in which the Prince Consort took so much interest, are models, and the plans of some of them which are exhibited will be much admired, and we hope imitated, by many landowners visiting the exhibition. Amongst many other interesting things, a plank

cut from Herne's Oak, and a grand root cutting from a larch 80 years old, are worth a special note. The remaining space in this transept is filled with specimens of wood from the Scotch estates of Munches and Methven, Perthshire, the Duke of Athol's woods (a very fine collection), the Duke of Devonshire's Irish estate of Lismore Castle, and the exhibits sent from Kew Gardens, mostly woods which were shown at the New South Wales Exhibition.

Continuing our tour along the right hand side of the centre nave devoted to the exhibits of British Colonies and Foreign Governments, which, with a few notable exceptions, are in a backward state, we come first to a very fine display sent from the Cape of Good Hope. There is a variety of handsome and useful hardwoods shown, mostly polished specimens, amongst which we may name stinkwood, hardpear, redwood, ironwood, white els, kaerswood, saffron, whitepear, assegai, &c. There is also a well-made model of a timber waggon, containing fourteen different kinds of wood, and a curious necklace and pair of earrings made from Cape melon seeds. The next section is that of Mauritius, from which Mr. J. Horne, Director of Forests and Gardens, has sent a remarkably fine collection of specimens of fibres and woods grown in that country. The Indian section is a thoroughly representative one, and occupies the whole of one transept, and thanks to the energy displayed by Colonel Michael, who is in charge of it, is in quite a finished state, and of a most interesting character. To all interested in Indian forestry we commend a careful perusal of the preface to the Indian section in the official catalogue, written by Sir George Birdwood, C.S.I. It does not fall within our province to notice the fine collection of trophies of the chase comprised in this section, and which, we suppose, are understood by the executive committee to form an important part of the subject of forestry, judging from the large amount of space they have devoted to them, but the collection of woods is worthy of a careful study. The local names are in some cases confusing, but two woods, called respectively "padowk" and "berar," struck us as being particularly worth the notice of cabinet-makers. Our next call was a particularly interesting one, and we stayed a long while in pleasant conversation with Mr. Meldrum, who is in charge of a very excellent collection, sent him by the Maharajah of Johore, who seems to be particularly alive to the value of his forests, and is turning them to account in a business-like manner, which one would hardly expect from an Eastern potentate. The independent State of Johore, as our readers may be aware, forms the most southern part of the great Indian Peninsula, and is separated from Singapore by the Straits of Malacca. This territory contains, it is said, an enormous amount of valuable timber, and there are hundreds of square miles of virgin forests. The variety of timber may be gathered

from the fact that the present exhibit contains specimens of no less than 357 different kinds. At the town of Johore Baru, the Maharajah has erected what is probably the largest saw-mill in Asia, and has fitted it throughout with first-class machinery, from the foundry of Messrs. McDowall & Co., of Johnstone, near Glasgow; there a large trade is done, both to meet the local demand, and also for export to Bombay, Calcutta, Australia, &c., and we were informed that three large ships, of 1,000 tons each, were lately loading timber at one time. There are numerous models and other things in this collection in addition to these specimens of wood, and we hope on a future occasion to return to this interesting subject.

From the south of India to the north of the American Continent is a long journey, but such trifles of distance are nothing at an International Exhibition, and accordingly a few steps brought us to the display of the New Brunswick Land and Timber Company. We are sorry we cannot congratulate the Government of New Brunswick on having sent a representative display, and it is much to be regretted if any false notion of economy has prevented them from voting the necessary funds to have their great forest treasures adequately shown at this important exhibition. From a chat with Mr. E. Jack, in charge of this exhibit, we gathered that the supply of first quality pine in New Brunswick is now very limited, and it is on the hardwoods, such as birch, beech, maple, and ash, that his company chiefly rely. We saw some very handsome specimens of these woods, in which there ought to be a larger trade done with this country.

Passing several interesting exhibits not directly within our province, and descending the left side of the main avenue, we pass Messrs. Churchill & Sim's specimens of foreign hardwoods, and come to a rather disappointing collection from Scandinavia. Sweden, with the exception of a good collection of boards arranged in columns, bearing Messrs. James Dickson & Co.'s well-known brand, and Messrs. F. Coster & Co.'s Uddevalla exhibit of trellis-work, mouldings, and barrels, is hardly represented at all. Norway relies on the good displays sent by Mr. Treschow-Fritzoe, of Laurvig and two firms of nurserymen.

British Guiana has a splendid collection in one of the transepts, containing specimens of greenheart, litterwood, and other handsome woods, many of which are but little known in this country. Denmark has a nice show of forest plans and tools, also photographs and maps. Reaching at length our point of departure, passing *en route* for the very fine and complete collection organized by the Scottish Arboricultural Society, we pause to take a good look at the Mammoth *sequoia* exhibited by the Californian Redwood Company. This giant of the forest, of which only the shell is shown, cut 5 feet from the ground, is 13 feet in diameter and 41 feet in circumference; height to first

branch 150 feet; total height 250 feet; estimated age 2,000 years. Stated to have produced 75,000 superficial feet board measure, and 6,250 cubic feet good timber.

Having now completed our tour of the main building, we may just mention that the centre is filled with a good collection of miscellaneous exhibits, including one of Mr. Gladstone's axes, and some chips from a tree felled by the right hon. gentleman, a good show of wood pulp, and the machinery in motion, which are both extensive and interesting. The Robey engines are there in great force, and are employed by the executive committee to drive the electric lighting machines, electric railway, &c. The wood-working machinery, with the exception of Messrs. McDowall and Sons, who send by far the most complete display, is in a backward state, but in a few days Messrs. Thos. Robinson and Son and Messrs. Sagar and Co. will doubtless be in working order. Messrs. McDowall and Sons have sent 17 machines in all.

Here for the present we close our notice of this most interesting exhibition, and in concluding we must say that there is an enormous mass of interesting information to be gained by a visit to it, and we doubt not that during the summer numbers of our readers will visit it and judge for themselves of the great efforts which the committee have made in securing the success of the first International Forestry Exhibition.

In future issues we shall give particulars of the various exhibits interesting to the timber trade, particularly the wood-cutting machinery exhibited by the various firms.—*Timber Trades Journal.*

SAWS.—The *Lumber World* says the Mechanics Association of Muehlhausen, in Germany, in their last annual report take a very decided ground against the use of circular saws, and advocate their abolition entirely wherever such action is possible. They base their conclusions upon the reasons that the use of circular saws involves more danger to the operators, that they require more power and waste more wood, and that their only advantage consists in a price smaller than that of band saws. The Germans use at the present day among their furniture-makers, carpenters and joiners, thirteen different varieties of saws, each one of which has its own peculiar size of the teeth, as well as a different relation of the teeth to each other. How important the thin saw blade is, not only as a means to save power, but also as a means to save wood, can be seen from the following. A log of walnut, 4 metres long and 1 metre diameter, cut into 20 pieces by the new horizontal saw frame saves 30 millimetres of wood when compared with the cutting of the old fashioned vertical saws. This is equal to a profit of 9 to 12 dollars. For Germany, where annually 100,000 cubic

metres of this wood is used in the various industries, this would represent a saving of 37,500 to 50,000 dollars. The greatest enemies of saws are the particles and pieces of iron found in woods; these are often driven in some form into young trees, and succeeding growth covers them up entirely. A curious collection of such ingrown iron particles was recently exhibited in Germany. It had been obtained from America, Prussia, Germany, Spain, and other countries, and exhibited the queerest forms of wood formation covering particles of iron of various shapes and sizes, whose presence was revealed only by a breaking of the teeth of the saw, and which without the cutting would have remained invisible to the human eye.—*Timber Trades Journal.*

THE YEW.—The yew is found here and there all over the country; it has been known to attain huge dimensions, although we are more familiar with it in connection with a shrubbery, as a shrub, than as a timber-growing tree. It is one of the most slow growing trees, and when cut down is also the hardest and compact. Where work of great strength is required the yew is found to be highly suitable, and it is said to be a wood that will endure without end. It has scarcely ever been discovered in a state of decay when found in use. It is celebrated for its toughness and elasticity and it is easily split. The colour of the wood is very beautiful, somewhat resembling orange-wood. The cabinet maker ranks it the highest amongst all the fancy woods for veneers for furniture, its rarity in a large state preventing the use of such fine timber in boards for the making of furniture. Although it is certainly too fine a wood to be employed for such purposes, there is no other wood to compare with it for machinery work—such as wheel cogs and screws, and axle-trees for carts—for strength and indestructibility, but its common use for these purposes is prohibited by its scarcity. Its most important use, as already stated, being for veneers, in which from the fine rich colour and the beauty of its veins exceed that of any other timber, and these veins extend through the roots.

The yew is very much used for the making of bows, for which purpose it is superior to any other wood.

The timber, when brought in, should be cut up into planks of rather a heavy thickness, from two inches and upwards, and allowed to season, which it takes a longer time to do than any other wood, but it loses almost nothing of its bulk; this is no doubt owing to the slowness of its growth and fineness in the grain.—*Timber Trades Journal.*

NOTE.—There is a large supply of yew wood in our Himalayan Hill Forests, and yet we have not yet heard of any demand for it.—[ED.]

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THE BABUL MEADOWS OF THE SHOLAPUR DISTRICTS.

By R. FAGAN, *Assistant Conservator of Forests, Bombay.*

INTRODUCTION.

MY chief object in writing this treatise is to bring the babul more prominently forward than it at present seems to be. It is the tree that is to be the principal species in the great reboisements now undertaken in the plain talukás of the Deccan. It is at present most *shamefully grown, but nevertheless put to* innumerable uses. If the growth of babul is increased and improved, the waste in the timber will be lessened, to say nothing of the advantages to commerce generally by the use of a good article instead of an indifferent one in constructions of all kinds. And further, there is no doubt that if its growth is increased the use of wood fuel will also be increased. I do not consider that this treatise is by any means exhaustive or infallible, and I shall be glad to receive any information in correction of, or in addition to, the remarks I have made.

CHAPTER I.

The Babul Meadows of the Sholapur Districts, their origin and existence.

Lignified vegetation of Sholapur.—It is often stated that a more treeless country than the Sholapur Districts does not exist in the Bombay presidency. This is an error which arises from the fact that the country is one vast undulating tract of land, and were you to stand on the highest vantage ground, yet in the neighbouring dip there might be an excellent babul meadow not 500 yards off, and you would never see it. The points visible to the eye in taking in the landscape are only the "*mals*" or summits of the undulations, and these are bare indeed. There are many causes to account for this bareness, such as the poor-

ness of the soil, murrum and other rock of basaltic nature being within one-quarter of an inch of the surface. Again, these uplands are the sheep pastures of a great sheep-rearing district, and this is enough to justify the absence of trees, leaving out of the question fires and other enemies of lignified vegetation.

I repeat that the plains of Sholapur are not treeless, and that the quantity of wood grown will compare favourably with that of any of the plain talukás of the neighbouring Districts. How could wood sell at the Sholapur spinning mills at Rs. 5 to 6 per ton, and at the Barsi mills at Rs. 3 to 4 per ton, and for less than the labour employed to fell it in the villages remote from large towns. It is in the dips or "lawans" that one must look for lignified vegetation. These lawans are annually refreshed with soil washed during the rains from the "mals," which have not sufficient vegetation to retain any detritus or disintegrated portions of the rock. This detritus is of the richest kind, and forms the black soil of the Deccan. It leaves the "mals" little by little, but the process has been going on for many ages, as may be seen by the complete absence of abrupt scarps.

Origin of the Babul meadow.—But to proceed, it is then in these "lawans," choked with the best of soils, that babul and *other trees are to be found in abundance. Let a field of this soil* be overrun by sheep and goats (after the crop is taken off) in the month of April, when these ruminants are fed on babul seed, the next year a thick crop of babul seedlings will be the result. Let this be protected from the teeth of the originators, and in two years no one will be able to cross it, so dense will be the growth. It is only in times of a famine extending over several years that frequent examples of what I have stated can be found. The plough soon asserts its own, the ruthless hand of the shepherd cuts the leading shoot of each babul to feed his herd, the lower branches are pulled at, eaten and destroyed by the flock. And what remains? A hideous set of stumps around each field which live a while in spite even of the human scarecrows who deprive them of every branch once a year, and these babuls grow up torded worm-eaten miserable creatures of the vegetable kingdom.

Absence of large specimens.—I believe myself that there are few trees in the Deccan more picturesque and with more subtle outlines than a babul grown under favourable circumstances. Given protection and a fair soil its dimensions are very respectable. In 1881 there was a babul about 40 years of age growing in the Gursala reserve, Pandharpur, full 80 feet high, with a girth of 14 feet measured breast high, a larger one than this was felled in the same reserve some 3 years previous to the above date.

There are meadows in the Sholapur Districts which used to be under a "quasi" protection before the advent of the For-

est Department, and in these one does find some fairly grown trees, but the district generally shows very poor specimens. For the origin of these trees was as above described, and they were not allowed to be swept away for cultivation. The order being that the trees on these waste lands open to grazing were *the property of the Government and not to be cut.* This rule was never rigorously enforced, and it was solely in Kurans, where sheep and other cattle could not graze during the greater portion of the growing season (the monsoon), owing to the state of the soil, that vegetation got a rest, and consequently a start of its enemies, and grew in spite of them. But scarce a tree escaped mutilation to some extent, and in 1881 there was not one completely sound babul tree over 7 years of age in Sholapur.

Actual condition of the old Babul meadows.—These babul *Kurans then were allowed to grow as best they could.* Certain meadows escaped beyond the powers of sheep and goats, and look very respectable groves to the uninitiated eye; they however present the same appearance at 20 years that they did at 15 and that they will at 30. They are formed of trees (*en état très clair*) that run about 30 to 40 feet high, and are every one unsound. The amount of wood to be got from them varies between a half to a whole candy of 784 lbs., but seldom more. There is no deceiving oneself in entering a reserve of this nature. The trees are past maturity, or they rot more per annum *than they grow, and should be cleared away to give place to a* fresh and properly protected growth. And why this halt in growth? I have heard it asserted that babul commences to rot after it has attained 4 feet in girth. Rather before that I think, considering the treatment it is exposed to. The real reason of the halt is, the trees are stunted and rotten because they have been so badly treated, and not because they are 4 feet in girth. Babul will grow to the dimensions I have mentioned above if only left alone and the soil be suitable.

Future of the Babul meadow.—Such is the origin and growth *of the babul meadow when left to the sweet devices of* Dhondiba the *dangar* and Ragu the *mahr*. What the babul meadow will eventually become, when regenerated and grown to maturity under strict conservation in these Districts, may still be a matter of conjecture, but one conjecture is pretty certain of being true, viz., that it will produce the maximum amount of sound timber that the soil is capable of, together with the maximum diameter possible for each tree to obtain, and given the soil good and protection perfect, the babul will be more than 4 feet in girth.

CHAPTER II.

Characteristics and uses.—The babul (*Acacia arabica*) belongs to the great order of the *Leguminosæ*.

Locality.—It is found from the Punjab to Behar in the Western Peninsula, in Ceylon, in Hindustan, and again in Arabia, Egypt, Tropical Africa and in Natal.

Soil.—In the Sholapur Districts it is found growing well in the deep black soils, but to the greatest advantage in the white sandy soils thrown up along the banks of rivers. It grows in a more or less stunted condition on the worst soils of these districts, such as the calcareous soil formed almost entirely of "kankar," and known locally as "chopan jamin," and it forms a scrubby bush even on the mals themselves. Irrespective of the constituent elements of the soil, I should say the most suitable soil for the babul is one that remains fresh even during the greatest droughts. Babuls exist on drier soils than this, but their existence is not natural, as they remain bared of leaves from April to end of May.

Climate.—The most suitable climate for the babul is of course tropical, and as it grows so well in the Deccan, great humidity in the atmosphere is not essential but beneficial. As far as elevation above sea level is concerned, it is impossible to fix the maximum and minimum at which babul is to be found in the Sholapur Districts, for it is found everywhere in this vast plateau.

Bark.—The bark varies from rugged and black on the trunk to soft and downy green on the youngest branches.

Branches.—The year's branches are very straight, but become torded and straggling with age. The cover is nevertheless light.

Trunk.—The trunk of the tree has invariably the appearance of "fibre-torse," the fibres of the bark twisting round the stem in a spiral.

Leaves.—The leaves are composite, the leaflets of a delicate green, of $\frac{1}{8}$th to $\frac{1}{4}$th of an inch in length.

Flower.—The flower is globular in shape of $\frac{1}{2}$ inch diameter, and yellow and sweetly scented.

Fruit.—The pods are coriaceous, hanging downwards, several in number, with 8 or 12 seeds in each. The length of the pod varies from 3 to 6 inches by $\frac{1}{4}$ to $\frac{1}{2}$ inch in breadth.

Spines.—The branches are covered with spines, which are extremely hard and piercing on the older branches.

The root is a tap root, there are also minor buttress-like roots which ramify in all directions close to the surface.

Sap and ripe wood.—The sapwood is white, the ripe wood darkens from the exterior, where it is brown to almost black at the centre. There are seldom more than four annual rings of sapwood. The sapwood is soft and porous, the ripe is hard and seems to lose the porous qualities with age, owing to the secretion of gum in its tissues. The wood just above and all below the "collet" of the tree is the hardest and most prized.

Variety of the Babul.—There is a variety of the babul common in the Sholapur Districts known as the "Ram Kati;" I

have never been able to ascertain, but it appears to me that it is an accidental variety that may spring from the seeds of the common babul. It is in all points, except shape and ramification, similar to the common babul. This tree resembles in stem and ramification the Italian poplar so common on continental road-sides.

Uses of the Babul.—The uses of this tree are innumerable. Its timber is used for making the famous Bijapur cart, for lintels and door posts, window frames, the panelling of light carriages of native manufacture, in planks for shutters, for ploughs, yokes, and that portion mentioned above as the most prized is used for oil mortars. I have never found it used for beams or rafters in any moderate sized dwelling, which would lead one to the conclusion that it has not good lasting qualities. So much for the ripe timber. The wood of the branches and unsound stems make excellent fuel. The fruit is used for feeding sheep, and forms a great source of support to them during the hot weather when grazing is not available. The bark is highly valued by the tanner and dyer. Further, this tree secretes in its sapwood the well known 'false' gum arabic, which is in a semi-liquid state during the months of February, March and April, and should a branch be broken or a portion of the stem punctured or injured, the gum escapes; but the quantities in which the gum deposits are very small, and I have not discovered any means by which the collection could be made remunerative in Sholapur.

Age.—The common babul lives to about 60 years in these Districts. The approach of death is easily determined by the extremities of the branches drying and bearing a square-tipped appearance. These branches eventually die and rotting infiltrate rain water to the trunk, which in turn rots.

Defects, &c.—Attacks by insects.—This tree often succumbs in its youth to the attack of the larvæ of the various species of the carpenter bee (*Xylocopa*). The largest of these larvæ, which all go by the name of "Humany," is about 1½ inches long, nearly as thick as an ordinary man's thumb, and may be black, red or even white. The larvæ attacks a tree in full vigour, sawing the tap root as cleanly as if the operation had been performed with a saw. I have, however, never seen trees of a greater dimension than 6 inches diameter at the soil attacked in this way. When the tree first shows signs of disease, it is just possible to find and kill the grubs, but if the tree is dead they will not be found, having left, owing to the nourishment from the juices of the tree ceasing. The trees of 6 inches diameter and larger are generally attacked by several of the grubs, which also I feel confident have the power of destroying the life of the subject attacked, but the cause is not direct, but emanates from the decay caused. This insect generally may be said to kill outright young babuls of one or two year's growth.

Another insect not unlike the common river cadiz worm, only that it lives on land and not in water, attacks this tree in full vigour, but does it little harm. It strips the spines off the branches, and builds itself a hut therewith, and seems to nourish itself by nibbling the bark of the youngest shoots so much so that one is often led to believe that a young tree when covered by many of these worms is dying. I know of no other animal that attacks the cambium bark or wood of the babul as long as its wood remains sound. As soon as the tree becomes rotten, or has a rotten portion near the surface, it is attacked by innumerable animals, and the carpenter bee lays its eggs in any cavity that presents itself, its young boring deep holes which permit infiltration of rain water. 'Maunder' asserts that the bee itself has powerful jaws and bores, of this I have my doubts.

Dry Rot.—All other defects in this wood may be summed up in the words "dry rot," which arises from some accident by which the cambium has been exposed and continuity in the tissues broken, *e.g.*, barking and lopping off a large branch, the end of which dries and rots, and thus carries infection to the stem of the tree. I may be wrong, but I have never on all the sections of babul that I have examined, discovered a spontaneous defect in the tree. All flaws having been traced to one or other of the above sources. I am, therefore, unable to reconcile what I have so often heard stated, that the babul rots on attaining 4 feet girth, or what must be the same thing a certain age. Now I have seen trees perfectly sound over 4 feet girth, and the girth of the tree does not depend so much on its age as on the soil it grows in; moreover, if this dimension was the limit after which spontaneous decay commenced, then it surely ought to commence in the centre or oldest portion of the tree, but I have never seen one case of this, all defects were owing to exterior causes.

Age and size not the only cause of decay in large and mature trees.—I will now proceed to give some examples of what I have actually seen on this head. A babul showing signs of maturity was felled in a departmental felling, it measured 6 feet girth at 5 feet from the ground. It was an exceptionally well protected tree, and I estimated its age when down at 50 years. The stem was sawn into lengths 6 feet long by the purchaser, and on all the sections not a sign of decay had set in.

On another babul 7 feet in girth I discovered a section such as *Fig.* 1, from which it was apparent that in the fifth year of growth of that level, a branch had been clean lopped or the tree barked. From *ab* as base two triangles *abc* and *abd* were formed by "dry-rot" of a darker colour than the wood. The apex of the former triangle being at the centre of the tree, and the apex of the latter at the point where the bark had rejoined. I noticed at *ef* on the vertical section a circular blur, and from *d* to *g* horizontally a line of light coloured tissue running

BABUL MEADOWS OF THE SHOLAPUR DISTRICT.

Fig. 1.

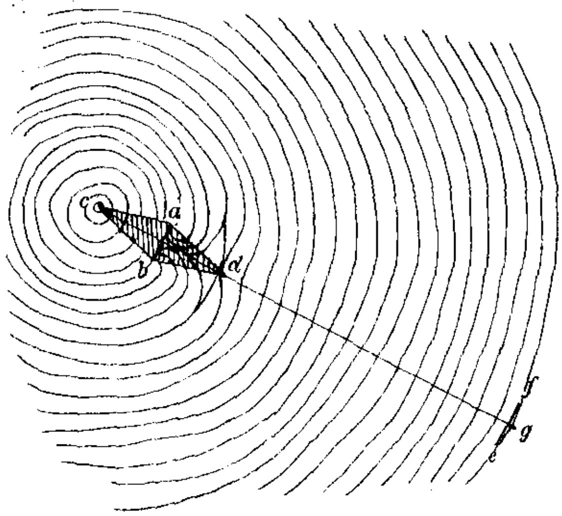


Fig. 2.

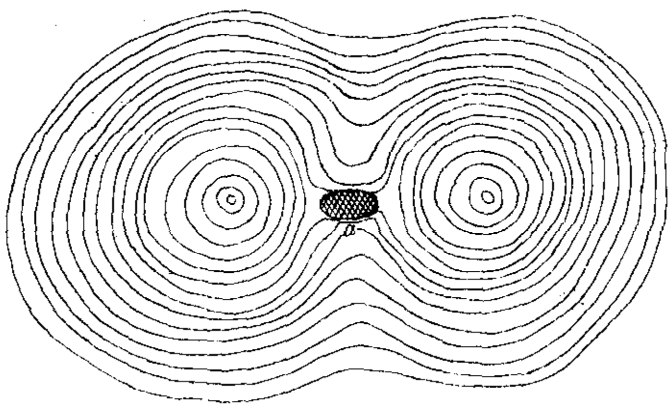
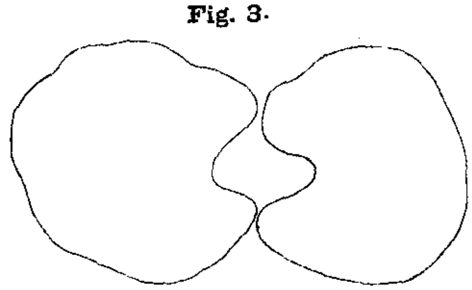


Fig. 3.



Litho. T. C. Press, Roorkee. THOS. D. BONA, *Supdt*

through those points of the annual rings, where they bent in conformity to the one they covered. The wood was rotten in these two triangles, and could be picked out easily with a knife. The disease it will be seen was evidently greatest where it had first commenced, and I noticed it was spreading upwards and downwards more than horizontally. This was doubtlessly caused by the peculiar run of the fibres which lie end to end in the vertical sense, thus offering themselves in the ascent and descent of the sap more easily to decay, there being but little horizontal flow of fluid matter between these tissues. All the forms of rot had this peculiar section, the outside mark on the bark differing according to the primary cause.

I once found in the part *abd* instead of the darkened portion the stump of the branch that had been lopped off in years gone by. It was closed over by the annual rings and shut in hermetically, but too late to prevent decay, and the same phenomenon occurred in *abc*. Again, a more conclusive case came under my observation where the triangle *abc* had not its apex in the centre, but would have had it after a sufficient amount of time. This clearly shows, I think, that rot does not emanate from the centre, or oldest portion of the tree.

I had often enquired of natives whether they could show me a tree where the rot emanated from the centre, as they themselves say the babul rots while growing from the centre. One man told me he had a case to show me; I found in the centre of the tree, true enough, a black spot about the size of the palm of the hand. I picked at this black lump, and eventually got it out, it was nothing more or less than a piece of bark. And now to explain! The black spot is represented in *Fig.* 2 at *a*, and what the man considered the centre and oldest portion of the tree was nothing more than the point of contact of two trees which had joined and grown into one stem. The pressure having caused the bark to yield on the outer phlanges of two projecting buttresses, and the cambium of the two trees uniting the portion between the two projections got closed in, as shown in a somewhat exaggerated form in *Fig.* 3, and far from being rotten it was perfectly sound.

(To be continued.)

(To be continued.)

PROGRESS OF FORESTRY IN INDIA.*

By D. BRANDIS, Ph. D., F.R.S., C.I.E.

THE long period of peace, of good and just government, which followed the consolidation of the British Indian Empire, the construction of railways and other public works, and the rapid increase of trade and prosperity, have contributed much to ac-

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* Written for the Journal of the Scottish Arboricultural Society.

celerate the destruction of forests in India. Over large districts and entire provinces the forests have been cleared to make way for the plough and the increasing population, and when forests were left, most of the accessible timber was cut and brought away to be used as fuel and charcoal, for shipbuilding, for railway sleepers, for bridges and other buildings.

Hence it came to pass that forests, which in old days were regarded as a thing to be got rid of and as an obstacle to civilisation, attracted attention, and that the necessity of preserving them began to be considered. As early as 1844, Mr. Conolly, then Collector of Malabar, commenced planting teak on a large scale at Nilambur, in his district, in order to provide timber when the forests, which were rapidly disappearing, should be exhausted. In 1839 and 1840 the Government of the Bombay Presidency issued orders to stop the cutting of teak wood on Government land, and in 1847 Dr. Gibson was appointed Conservator of Forests in Bombay. In the same year Mr. Colvin, Commissioner of the Tenasserim provinces, commenced organising a Forest Department at Moulmein; and in 1856 Dr. Cleghorn was appointed the first Conservator of Forests in the Madras Presidency. Five years later, in 1861, Dr. Cleghorn was deputed to the Punjab to examine the forests in the Western Himalaya, and in 1866 he was selected to officiate as Inspector-General of Forests.

The system which has now been accepted in the two Presidencies of Madras and Bombay and generally throughout India, consists in this, that from among the vast area of forest and waste which is at the disposal of the State, certain lands are selected and demarcated, which are called Reserved Forests. They might have been called State forests in accordance with the practice which obtains in those countries of Europe where the development of forest management has been analogous to what has taken place in India. The Reserved Forests in India are State forests in the sense in which this term is used in France, Germany, Austria, Denmark, and other countries of Europe; but they are not the only forest lands at the disposal of the State, and hence they are for the present called Reserved Forests.

The administration of forests generally, and in particular the constitution of these Reserved Forests and the procedure by which they are gradually freed from customary rights, which villagers and private persons have been in the habit of exercising in them, are now regulated by legislative enactments. The Indian Forest Act was passed in 1878, the Burma Forest Act in 1881, and the Madras Forest Act in 1882. Other local enactments are in force in several districts and provinces where peculiar circumstances required special legislation. In the review of forest administration for the year ending March 1882, written by Dr. Schlich, Inspector-General of Forests to

the Government of India, the total area of Reserved Forests on that date is stated as follows :—

		Sq. Miles.
In the provinces under the Government of India,		35,242
Less second class Reserves in the Central Provinces,		16,842
		18,400
In the Madras Presidency,	... ...	1,182
" Bombay "	... ...	9,789
	Total, ...	29,371

A word should be said regarding the second class reserves in the Central Provinces. Legally they are reserved forests like those of the first class ; no fresh customary rights can accrue in them, and no land can be alienated without the sanction of Government. But they have not been protected strictly, as the first class reserves have been, their boundaries are not clearly marked on the ground, and they are cut up by cultivation, which has frequently been permitted in them without fixing the limits within which it may be carried on. Eventually a portion of these second class reserves will probably be given up for cultivation, while the remainder will be strictly protected and added to the first class reserves. In the Central Provinces, as elsewhere, the policy followed has been, in the first instance, to concentrate operations upon limited areas ; but now, since an efficient staff of forest officers has gradually been organised, it has been found possible to expand operations and to take in hand larger areas. In the area shown as Reserved Forests are included 402 square miles of forests leased from Native States, chiefly in the North-West Himalaya. In all provinces large additions to the reserved area are steadily made, chiefly in the Presidency of Madras, where the work of forming Reserved Forests has hitherto been backward.

The extent of country under British administration in India, not including Native States, may be put down at 870,000 square miles, of which about 246,400 square miles, or 28 per cent., is cultivated, while the rest, or 623,600 square miles, is forest, waste and pasture land ; much of this, however, is private property, and the total area of forest land at the disposal of the State is not in all provinces accurately known. The Reserves it is intended to maintain permanently as forest, and the remaining lands at the disposal of Government will be available either for the further extension of the State forests when such may be found necessary, for the formation of village forests to be managed by the village communities for their own benefit, for pasture lands, or for the extension of cultivation.

The trees of which the Indian forests consist are entirely different from those common in Europe. The variety of trees is

much greater; in Great Britain there are only about 40 species of indigenous trees, while in India they number over 2,000. Only in the temperate climate of the North-Western Himalaya is the general character of the forests similar to that in Europe, and there are even a few kinds which are common to both countries, such as the yew and the boxwood. Here are found forests of oaks and coniferous trees, with an admixture of maples, elms, hornbeam, birch and poplars; the banks of streams are lined by tall alders; the shrubs and underwood consist of willows, barberries, roses, and brambles. The genera are often the same, but the species are almost all different, and with them are associated many kinds which have nothing in common with the trees and shrubs of Europe. In these forests the most important tree is the deodar *(Cedrus Deodara)*, which forms extensive forests at an elevation of between 6,000 and 9,500 feet; these forests are rarely pure, but the deodar is largely mixed with other less valuable trees, partly conifers, partly oaks, and others. The value of this noble tree, which under favourable conditions attains a height of over 200 feet, consists in the great durability of its timber. In the climate of India most woods are apt to decay and to be destroyed by insects a few years after having been cut. Deodar is one of the few durable woods in India, and beams of it have been known to last several hundred years.

A large belt of forest stretches at the foot of the Himalaya from the Punjab to Assam, and the two most valuable trees in this forest belt are sal *(Shorea robusta)* and sissú *(Dalbergia Sissoo)*. As in the case of deodar, their value consists mainly in the durability of their timber. Sal belongs to the natural order of *Dipterocarpeæ*, which has no representative in Europe, and is remarkable from the long wings on the tops of the large round seed. This tree is eminently gregarious, and on the stretches of high land between the rivers which issue from the hills, it forms extensive forests, almost pure, the ground under the old trees being generally covered with a dense mass of seedlings. The sissú tree, which belongs to the natural order of the Furze, the Robinia, and the Laburnum, forms forests, partly by itself, partly associated with the Cutch tree *(Acacia Catechu)* and other kinds, near the rivers and on the deposits of sand and shingle which extend along their banks. Sissú extends far up the valleys into the hills to an elevation of 3,000 feet. The timber, which takes a fine polish, has not the great hardness of sal and works better; it is used largely for furniture and carriage-building. Extensive plantations of sissú have been formed, chiefly in the Punjab, and the establishment of a good system of rearing sissú on a large scale, and at a moderate cost, is due mainly to Mr. B. Ribbentrop, the Conservator of Forests in that province. *Acacia Catechu* is not, like sissú, limited to the sub-Himalayan forests, but is also found in Burma and other parts of tropical India; its dark red heartwood is extremely durable,

and is prized for pestles of oil mills, for rafters and house posts. But the most valuable product of the tree is Cutch or Catechu, an excellent tanning material, which is extracted by simmering chips of the heartwood in water, and boiling down the red fluid into a hard shining black mass—the Catechu of commerce.

In the moist climate of Assam, where the sal tree attains its eastern limit, the India-rubber tree (*Ficus elastica*) is found in the dense evergreen forests at the foot and in the valleys of the Himalaya and of the Naga Hills, which bound the Assam valley on the south. This is a huge evergreen tree of the fig tribe, with thick leathery shining leaves, which sends numerous aërial roots down to the ground from its branches. The white milk which exudes from cuts made in the stem and roots is collected and dried, and forms the caoutchouc which is exported from Calcutta. The tree is found chiefly outside British territory in the hills which surround the Assam valley, and which extend from the head of that valley north towards Arrakan, as well as in Native Burma, north of Bhamo. The export of this article from India in 1881-82 amounted to 10,680 cwt., valued at £108,843; but owing to the reckless treatment of the trees in tapping, this supply, which mainly comes from beyond the frontier, must eventually diminish, and hence it became necessary to establish plantations. In Assam 1,000 acres are now stocked with *Ficus elastica*, some of the trees being nearly ten years old, and those in the older portions being from 30 to 40 feet high. The success of these important operations is chiefly due to the skill and perseverance of Mr. Gustav Mann, the Conservator of Forests in Assam. The caoutchouc plantations are being steadily extended.

Sandalwood (*Santalum album*) is a small evergreen tree, with elegant hanging branches and black berries, the heartwood of which is valuable on account of its strong scent. It is used as incense and for carving, and is largely exported, chiefly to China. The native State of Mysore in South India is its chief habitat, but it is also found in the adjoining districts of the Madras Presidency, in Coorg, and in North Canara.

Of all Indian forest trees the most important is the teak (*Tectona grandis*), a deciduous tree of the natural order of *Verbenaceæ*, to which *Vitex* and *Verbena* belong, with large rough leaves, often 3 feet long. This tree is found associated with bamboos and a great variety of other trees, most of which have no, or very little, market value. Pure natural teak forests are rare, but they are sometimes found on dry and poor soil. In the island of Java teak is described as a more gregarious tree than it is in India; but the home of teak is in the moister regions of tropical India, and the most extensive teak-producing forests are in the Trans-Gangetic Peninsula, in Burma, and Siam. In Central India and on the Irrawadi river it extends to north latitude 26°.

It may justly be said that teak is among woods what gold is among metals,—it is not only exceedingly durable, but it works well, takes a fine polish, does not split or warp, and is neither very hard nor very heavy. The only timber, which might in some respects take a higher rank, is mahogany. Indian teak is more prized than any other timber, and it forms an important article of export from Burma to Europe and America; but the only ports where teak is now shipped in large quantities are Rangoon and Moulmein in Burma, and Bankok in Siam. Its price is exceedingly high at the present time,—as much as £15 to £16 the load of 50 cubic feet in the London market.

The following figures, which show the imports from all sources, foreign and British, into the ports of Rangoon and Moulmein, as well as the exports from these ports, all in loads or tons of 50 cubic feet, will give some idea of the great increase in the consumption of this timber since 1856. The figures are annual means for periods of eight, five, and three years:—

Periods.		Mean Annual Imports.	Mean Annual Exports.
		Tons.	Tons.
8 Years, 1856-57 to 1863-64,	...	85,000	77,000
5 " 1864-65 to 1868-69,	...	113,000	108,000
5 " 1869-70 to 1873-74,	...	133,000	98,000
5 " 1874-75 to 1878-79,	...	227,000	135,000
3 " 1879-80 to 1880-81,	...	169,000	135,000

During the last three years the mean annual yield of the Government forests in British Burma was 24,000 tons, and the imports from beyond the frontier amounted to 145,000 tons. But the forests beyond the frontier are worked without any regard to their maintenance, and it is impossible that they can much longer continue to yield the same quantities as hitherto. On the other hand the yield of the Government forests may be expected to increase considerably, and the aim is to increase the proportion of teak in these forests by protection and planting to such an extent as to enable them to yield annually and permanently a quantity equivalent to the timber at present imported into Rangoon and Moulmein. There are not many places where teak is found outside India and the Trans-Gangetic Peninsula; but the Burma ports and Bankok have not altogether the monopoly of this valuable timber. The teak forests of Java are reported to have an area of 2,280 square miles; they are under regular management by a Government Forest Department, and during the fifteen years from 1865 to 1880, 24,700 acres have been planted up. The natural teak (Djati) forests of that island, of which a graphic description is given in Junghuhn's excellent work on Java, are situated in the eastern or drier portion of the island, and, like the Indian teak forests, they were formerly overrun by the annual forest fires of the dry season. The stature

of the trees in the Java forests is described as small, only 50 to 60 feet on an average; while in Burma and near the Western Ghats the teak attains 100 feet and often more. Protection against fire will probably have the same beneficial effect in Java as in India, and the forests of that island may eventually be expected to contribute their share to the teak required by the world's trade.

There is a class of plants which gives a peculiar character to most Indian forests, and this is the bamboo. They are tall arborescent grasses, generally growing in dense clumps, consisting of numerous slender stems, often 60 feet high and more. The stems are hollow, light, and very strong, and they furnish most valuable material for building; but they are also used to make baskets and mats, and the walls, floors, and even the roofs of houses are often made of stout bamboo matting. The demand for bamboos is very large, many millions being annually floated down from the Burma forests, and they are exported from most of the larger forest districts in India. Only in some remote districts are the bamboos as yet without value. A project was started a few years ago to use the fresh shoots of the bamboo for the manufacture of paper, and extensive concessions were made by Government to the promoters of this project. Excellent paper from bamboo is made in China, and there seems no doubt that fresh bamboo shoots yield one of the most valuable of paper stuffs. But in most districts the stems fetch much more when mature than the paper maker could afford to pay for the fresh shoots, and in those remote districts where bamboos have as yet no value, the unhealthiness of the forests, the scarcity of labour, and other difficulties are in the way of this undertaking.

Besides the trees indigenous to India, much has been done to introduce trees from other countries, and in some instances they have succeeded remarkably well.

Of the trees of Northern Europe or of North America, none have been raised on a large scale, the climate being totally different. The olive, the sweet chestnut, the carob (*Ceratonia siliqua*), and some other trees of South Europe, have been introduced into Northern India, and of these the sweet chestnut promises to thrive well in some portions of the North-West Himalaya. The mahogany tree was brought from the West Indies about ninety years ago, and there are a number of large trees in gardens near Calcutta, which produce timber equal to that of the American tree. Great exertions have been made to grow this tree on a large scale in forests, but the success has, with few exceptions, been indifferent; in Pegu, however, there seems some prospect of the mahogany succeeding as a forest tree. An introduction from tropical America, the rain tree (*Pithecolobium Saman*), whose timber has no value, but which is remarkable on account of its extremely rapid growth, has suc-

ceeded wonderfully well in most of the moister districts of tropical India. Attempts have been made with great perseverance, and at considerable expense, to introduce several of the tropical American trees which yield Caoutchouc, and one of these, the Ceara rubber (*Manihot Glaziovii*), has been found to grow freely in the moister districts of tropical India.

The paper mulberry of Japan (*Broussonetia papyrifera*), which yields also the tapa cloth of the South Sea islands, is now cultivated in Assam and Burma, and promises to be an important introduction. In Japan, this tree is grown as coppice, in the same way as osier beds in England; and, if the experiments continue successful, its fibre may become a valuable forest product in India.

The most remarkable instance of a foreign tree is the Australian blue gum (*Eucalyptus globulus*) on the Nilgiris. Of this, as well as of two species of acacia, *viz.*, *A. dealbata* the wattle, and *A. Melanoxylon* the blackwood, forests have been raised, and around the stations on the hills these trees are now so numerous that they give a peculiar character to the landscape. The blue gum was first introduced in 1843, and there are trees at Ootacamund now thirty years old, over 13 feet in girth, and over 110 feet high. When young the tree shoots up with great rapidity, and under favourable circumstances trees ten years old are 80 feet high, with a girth of from 2 to 3 feet. After that age the growth in height is less—only about 2 feet a year, but they add greatly to their girth. 1,230 acres on the Nilgiris, on that portion of the plateau which is occupied by native villages and by European planters, have been planted by Government with the blue gum and acacia. The indigenous woods have here been largely cleared: those which remain are not very extensive, and the indigenous trees have an exceedingly slow rate of growth, so that the introduction of these fast-growing Australian trees has been most useful for the supply of timber and fuel. In order to ascertain exactly the rate of wood production per acre, valuation surveys were made in the summer of 1882 by Mr. D. E. Hutchins, then Assistant Conservator of Forests in Mysore, with the result, that in the plantations ten years old the stock standing on one acre measured 6,800, and in a plantation nineteen years old, 9,000 cubic feet of solid wood. The mean annual production of wood in these blue gum plantations, therefore, has up to date been at the rate of about ten tons, or 500 cubic feet of solid wood, per acre, which is more than five times the quantity produced by high timber forests in Europe. The acacias grow less rapidly, and they produce only about half the mean annual quantity per acre, but still they do much better than any of the indigenous woods.

The successful introduction of the larch and the Austrian and Corsican pines into Great Britain, and of many North American trees into Europe, justify the expectation that forests of a few

foreign species may be raised in India; but even these brief remarks will serve to show that in India trees may succeed well in gardens, and yet not answer when grown on a large scale in forests.

Forest management in India has commenced to yield a steady and growing annual revenue to the State. This revenue might be much larger if the forests were not managed with the chief object of improving their condition; hitherto cuttings have been restricted, and attention has been chiefly devoted to the formation and improvement of these Government domains. In the provinces immediately under the Government of India, the forests yielded in 1881-82 a revenue of £631,500, while the charges amounted to £393,000. Of this outlay £290,000 was expended upon cutting and carriage of timber and other matters connected with the collection of revenue; while on the formation, protection and improvement of the forests the outlay was £103,000. But the revenue is increasing steadily, and may be expected to reach a very large figure. In 1864 the first attempt was made to put together the financial results of forest administration in the different provinces, and the progress which has been made since that time will be seen by comparing the average annual figures of the five years commencing with 1864-65, with the figures for 1881-82 and 1882-83. These figures include receipts and charges of the provinces immediately under the Government of India, as well as of the Presidencies of Madras and Bombay.*

	1864-65 to 1868-69. Average per Year.	1881-82.	1882-83.
Revenue, ...	£360,000	£870,000	£950,000
Expenditure, ...	220,000	550,000	600,000
Surplus, ...	£140,000	£320,000	£350,000

By way of comparison, the average receipts and charges of the State forests in France and Prussia will here be stated. The figures for France are taken from the "Annuaire des eaux et Forêts" for 1884, and it should be noted that the receipts are those for 1880, while area and charges relate to 1884. The figures for Prussia are taken from the "Forst und Jagd Kalender" for 1884, and all relate to 1883-84. In both countries the State forest officers have also the general control of a large area of communal forests. The receipts include only cash receipts, and not the value of wood and other forest produce given gratuitously to right-holders and others. Outlay of capital and extraordinary charges, such as those for the construction of roads and buildings, the planting up of large areas of waste, and the operations for restoring the forest growth on low mountains in France, are included in the current expenditure of the

* The Forest Revenue for the three Presidencies in 1883-84 has been £1,040,000.

year, and this is also the practice in India. The figures for France do not include those relating to the forests in Algeria.

	France.	Prussia.
Area in square miles, ...	3,876	10,246
" in hectares, ...	1,003,948	2,653,913
Revenue, ...	£1,405,104	£2,618,570
Expenditure, ...	641,508	1,625,725
Surplus, ...	£763,596	£992,845

Both in France and Prussia the gross and net revenue per square mile is much larger than in India. A comparison of the rates per square mile would be without meaning, as part of the Indian forest revenue is derived from areas outside the Reserved Forests, while for France and Prussia the figures only represent the revenue of the State Forests. In these countries regular and systematic forest management has existed for several centuries, and the result may be seen in well-stocked forests, with a regular gradation of ages, which yield large annual crops of timber and other forest produce. In India the first real attempt to introduce systematic forest management is barely 30 years old.

But though the working of the Indian forests is as yet in its infancy, the principles followed are the same as those upon which the State Forests of France and Prussia are worked, the chief aim being steadily to inprove their condition, and never to cut more than the annual production by natural or artificial means will justify. Forest management, which aims at these objects, requires the following measures as essential conditions of success. *First*, effective protection; *second*, a good system to secure the regeneration of the forest, either naturally by self-sown seedlings or coppice shoots, or artificially by planting, sowing, and other cultural operations; *third*, good lines of communication to facilitate protection, the working of the forest, and the export of produce; and *fourth*, well considered and methodically arranged plans of working.

In the matter of protection, great success has been achieved, and the beneficial effects manifest themselves in the improved condition of the forests. One of the main points gained has been that over large areas it has been possible to put a stop to the annual forest fires. As is well known, one of the peculiarities of the Indian climate is that in most parts of the country the year is divided into a dry and a wet season. During the dry season, which never lasts less than five months, but generally much longer, the grass and herbs, the leaves, twigs, and rootlets on the ground get so exceedingly dried up, that a spark is sufficient to set large tracts on fire. Only the dense evergreen forests of the Himalaya and of the moistest regions of

India are safe from these fires; but in the deciduous forests which prevail in the plains and on the lower hills, the fires of the dry season are an annually recurring event. They are lighted by the hunter to clear the ground; by the herdsmen, who burn the old grass in order to get fresh herbage for their cattle; by the hill tribes, who raise their crops of rice or millet in the ashes of the forest, which they cut and burn; or they originate through the carelessness of travellers. The injury done by these fires to the forests is incalculable; trees are killed or hopelessly injured; seed and seedlings are destroyed wholesale; and the ground is hardened and impoverished. In the provinces under the Government of India, 4,283 square miles out of 18,400 were effectually protected in 1881-82. In some provinces a much larger proportion was reported to have been saved; thus, in the Central Provinces, one-half of the first class reserves was without fires in 1881-82, and in Berar two-thirds. When the idea was first started it was denounced as Utopian, and the attempt to put a stop to the annual jungle fires was regarded as a hopeless undertaking. Success was only achieved through indomitable perseverance, and at the cost of great personal exertion and exposure during the hottest part of the year. In the Central Provinces success in this respect has been chiefly due to the energy and perseverance of Colonel G. F. Pearson, who was appointed Conservator in 1863, and of Colonel Doveton, who succeeded him in 1868.

The reward has been a wonderful change in the condition of the forests. Before protection commenced they were often nothing but a thin and open scrub, with here and there a few trees which had managed to grow in spite of the fires. Year after year, as fire protection continued, this open scrub was replaced by a dense growth of trees, bamboos and shrubs, and the large blanks, formerly covered with high grass, gradually got stocked with self-sown seedlings and coppice shoots. The task of continuously protecting those forests against the annual fires would be hopeless, if the grass, generally the chief source of danger, were not killed out by the dense cover of the forest, which has gradually become stocked. So far the improved condition of the growing stock. The improvement of the soil is equally important; but here a remarkable fact should be mentioned. Black moist vegetable mould, such as covers the ground in beech and other forests in Europe, has not yet been observed in the Indian fire-protected forests; and it should be added that such black vegetable mould is not found as a rule in the evergreen forests of tropical India, through which the annual fires do not pass. In the deciduous tropical and subtropical forests which are protected against fire, leaves and twigs crumble into dust during the dry season; the surface of the soil is dark coloured, but, as far as experience up to the present time has gone, no layer of moist vegetable mould is formed.

Fire protection benefits the less valuable kinds equally with those species which are valuable. Planting and other cultural operations are therefore necessary, not only in order to stock blanks, bare plains or hillsides, with trees, but also to increase the proportion of the more valuable species in the forests. For this is a peculiarity of forestry in most parts of India, that those trees the timber of which is marketable are often mixed with other kinds for which there is no demand. Thus, in what are called the teak forests of British Burma the teak tree forms a small proportion of the forests, less than 10 per cent., and hence it is of the utmost importance to plant teak and otherwise to favour the growth of this tree at the expense of the other less valuable kinds. From a late report on the Burma forests, it appears that up to the 31st March, 1883, 11,221 acres had been planted with teak. This, obviously, is only a small commencement, and teak must be planted on a much larger scale in Burma in order to place the forests in a position to yield eventually the large supply which it is hoped they will furnish. The difficulty hitherto has been that those tracts where the teak grows best are extremely feverish, and that labour is scarce and expensive. Several plans have been tried, but that which seems likely to lead to the best results is to induce the Karens, who inhabit these forests, to plant teak in their hill clearings (Toungyas), where they raise a crop of rice, with vegetables and a little cotton, in the forest which they have cut down and burnt. While the crop is on the ground, the teak remains small, but grows rapidly afterwards. Colonel Seaton, Conservator of Forests in the Tenasserim division of British Burma, has the great merit of having succeeded, in 1868, in starting this system, which had been first suggested in 1856. The bamboos, which form extensive forests in the teak region, mostly flower gregariously all at once over large tracts, and after ripening their seed they die; the stems of the bamboo fall, and the ground is covered with a dense mass of dry stems lying across each other. Attempts have been made during the last few years to burn and clear these areas and plant teak, and it is possible that this also may eventually be developed into a good system.

(To be continued.)

FORESTRY IN JAPAN.

Being unable to spare time to write a full account of the International Forestry Exhibition just at present, I only send a short description of the Japanese Department, which I hope will prove interesting. This department struck me at once as being the one of most interest to us. The Japanese are commencing scientific forest conservancy much as we are, but they

are even fresher to the work, and I must say that in my opinion they are not lagging behind. The Japanese Commissioners were most courteous and gave me some details. The nucleus of the Department studied Forestry in Germany, and have now returned and started a Forest School in Japan. Unfortunately the head of the Forest Department (one of the Commissioners) can speak only Japanese, and it was difficult to obtain much information through an interpreter, especially as their modes of valuation are apparently peculiar. For instance, I was struck with the great number of workmen evidently employed on each work, and the liberal way in which work was carried on. I found contrary to my expectation that the cost of ordinary labour ruled rather higher than in Bombay, or say 6 annas a day, while skilled labourers, such as sawyers, &c., earned about Re. 1. The *Cryptomeria japonica* seems to be the great tree, and trees of 20 feet circumference were mentioned as common, and yet in reckoning up the profits the value of 'a tree on foot' was mentioned as one franc. I had great difficulty in explaining the difference between superior and subordinate staff, and am not sure that I really made myself understood, but the following figures were extracted for me from the administration report for 1880 :—

Total Superior Staff,	320.	Area of average charge		40 sq.m.
Total Subordinate Staff,	1,700.	,,	,,	12 sq.m.

But I was informed that this staff had been very much augmented during the past four years.

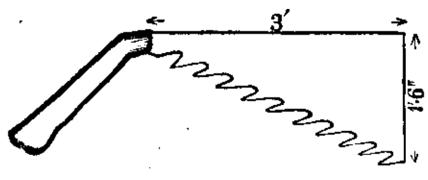
Among the exhibits I noted the following :—

A series of paintings of forest works. These are most interesting, and (though drawn in the perspective or rather want of perspective so familiar in Chinese pictures) give a capital idea of tree felling, timber slides, timber floating, sluices, weirs, &c. The trees represented are all of large size. Temporary beds are built on to which the trunks are made to fall (the tops and branches being first removed) by means of windlasses, and similar care to prevent damage is apparent everywhere in the slides and floating operations. I noticed one picture of felling by fire, but could not quite realize the details. It was an enormous tree, and apparently holes had been made through with the axe to cause a draft. All large wood is apparently squared on the spot before export. A series of models of weirs, sluices, slides, &c., are also very interesting. They are all constructed of materials found on the spot, *i.e.*, logs, creepers, bamboos, &c., and cages filled with stones are used as buttresses.

One model labelled "Weir at Awomari" shows particular ingenuity. It is evidently meant to obtain a head of water on a small stream, and so to produce an artificial freshet. The whole dam is of the roughest materials, and could be constructed with only an axe, and yet is evidently thoroughly efficient. The

gates closing the sluice are composed of planks, each one moored to the dam at the side of the sluice, and supported (against the current) in the centre by a vertical log, which is moored at top and kept in place at bottom by the end of a sapling in a socket. Above the sapling is put into or behind a 'catch,' made out of a forked stick, and a rope carried from the upper extremity of the sapling to the shore is the means by which the sluice can be thrown open. The whole idea seems to have been borrowed from a mouse trap.

There is a fair collection of implements and tools, including timber stamps, hammers, chisels, axes, hoes, spades, shovels, billhooks, saws, &c., &c. Some of these are of European and some of Native shapes, but all of Native make. The saws alone seem worthy of special remark. They are all one-handed and shaped thus, even the coarsest, having nearly 1 inch teeth, were made thus.



To me they seemed inferior to our double-handed saws. The triangular shape which is necessary (both pull and push being from the same end) to give strength and prevent the saw crippling must greatly increase the friction, and with the continuous labour must be a severe strain on the workman. However one of the Commissioners assured me that a good sawyer will easily cut out 180 to 200 square feet of planking with this instrument in the day, and thereby earn 2 francs. No other is used. I noted also a compass, and what is described as a sextant (apparently a dendrometer or kind of clinometer) in brass of Native manufacture. This instrument the Commissioner said had been used in its present form ever since Japan existed. A chart giving the following information most quaintly by colored proportional scales :—

I.

		chos.
Area of the whole empire, ...		38,563,716
viz.,	chos.	
Honshin, ...	22,846,603	
Shikoku, ...	1,837,344	
Kinshin, ...	4,158;464	
Okinawa, ...	244,026	
Hokkaido, ...	9,477,279	38,563,716

II.

Forest area exclusive of the island of Okinawa and Hokkaido—

	chos.
Government, ...	5,259,182
Private, ...	6,607,443

III.

Forest area in Honshin (main island)—

	chos.
Government, ...	4,526,803
Private, ...	5,466,218

IV.

Forest area in Shikoku—

	chos.
Government, ...	358,381
Private, ...	817,319

V.

Forest area in Kinshin—

	chos.
Government, ...	374,017
Private, ...	322,905

VI.

Forest per head—

	Tans.
Whole Empire, ...	3·25
Honshin, ...	3·525
Shikoku, ...	4·4
Kinshin, ...	1·32
One "cho", ...	= 2·4567 acres.
One "tan", ...	= 0·24507 ,,

A chart showing the distribution of forests arbitrarily divided into five different regions represented from the sea-level upwards by the following species :—

1. *Ficus Wightiana,*
2. *Pinus Thunbergii,*
3. *Fagus sylvatica,*
4. *Abies Veitchii,*
5. *Pinus Cembra,*

bearing subsidiary charts as follows :—

I.—Paintings of each of the above five trees, with leaves, flower and fruit of each on a larger scale.

II.—An ingenious table of maximum and minimum elevations of each of these five regions in each of the 44 provinces of the empire; thus showing at a glance the correspondence between the variations in altitude and latitude.

III.—A small scale map of the empire showing demarcated and undemarcated areas.

IV.—A horizontal projection of the main chart.

V.—A list of 199 trees as distributed in the above five regions, and a list of 117 shrubs found in the empire, with vernacular and botanical names.

A fine collection of fruits in spirits, seeds in test-tubes, &c., "canned" mushrooms, edible fungi, &c., vegetable wax camphor

and similar products in stoppered glass jars, cigarettes of *Sterculia platanifolia,* and so forth ; a very complete collection, and neatly got up.

A good class of turnery, cooperage, &c., consisting of barrels, milk pails, wash tubs, &c., of the familiar European patterns, the barrels hooped with platted bamboos and withes, the perfect accuracy of the jointing being specially noteworthy ; also solid wooden bowls ranging from 3 inches to 3 feet diameter, spoons, forks, ladles, &c., from the most barbarous shapes to the well-known "fiddle" pattern, tooth-brushes similar to those used by the natives in India, but superior in finish, with "tongue scraper" combined. Tooth-picks in neat bundles with paper wrappers, lucifer matches made in perfect imitation of the cheap Swedish kinds with blue boxes, red labels, dirty green wrapper complete, the label even bearing the inscription "Sakerhets Tandstickor." *Models of charcoal kilns, one kucha in* earth, the other pucka built of stone, and some twenty specimens of excellent charcoal of various woods.

The collection of fibres is small, but well selected. The fibres are shown raw, and worked up into foot-mats, coarse sacking, rope, and fuses, the two most important seem to be *Sterculia platanifolia* and a *Tilia.*

Bamboo and its uses are well shown, specimens of some 30 or 40 species are exhibited, the manufactured articles are similar to those of India, and show that great attention is paid to the minutest details.

A splendid collection of 270 kinds of timber—the specimens are in slabs cut uniformly 3 inches thick by 3 feet long through the centre of the tree, the bark being left on the edges ; each specimen is accompanied by a description giving—

(1). Native and botanical name,
(2). Description of tree, habitat, &c.,
(3). Average height and girth at 50 years and at maturity,
(4). Method of propagation,
(5). *Quality and description of wood,*
(6). Uses of timber,

and in most cases by dried specimens of leaf, flower and fruit, and in others the same hand-painted, all in glazed frames.

Also a fragmentary collection of some twenty specimens, exhibited by a private individual, of tablets of various woods framed with branch-wood to show bark, and hand-painted showing the leaf flower and fruit of parent tree.

The Japanese as a rule cube their timber immediately it is felled, and float it at once to the sea, where it is stored in tanks filled with equal parts of salt and fresh water until required for use. This is said to preserve the timber from decaying.

The Commissioner assured me however, that the specimens exhibited were cut from the green tree, and exported without

undergoing any special seasoning process. Of the result there can be no two opinions, the admirable condition of the specimens is most striking, scarcely a crack being visible in the whole 270.

There is also a most interesting collection of 40 specimens of trees ranging from 3 feet to 15 feet in height, with root and branches complete, and between four and five years of age. These are all of various European kinds grown from imported seed, and illustrate the progress made in acclimatization work.

Thirty framed photographs are also shown to illustrate the methods employed to arrest the denudation of bare hill sides by means of fascine works, pucka dams, &c., &c. Though unfortunately the photographs are so hung as to prevent a close examination, yet enough can be seen to show that apparently no expense or labor is spared in this department.

I have been obliged to pass over a large number of exhibits out of regard for your space, but believe I have enumerated the most interesting and noteworthy. I feel sure that you and all your readers will agree with me, from even this meagre account, that Japan has shown a spirit of enterprize worthy of our admiration. Personally I have been much struck by the clever way in which the Japanese have adopted and adapted all and just those ideas of European scientific forestry best suited to their climate and conditions.

FURLOUGH.

THE GOVERNOR OF MADRAS ON FOREST CONSERVANCY.

"THE third and the last thing we respectfully venture to invite your Excellency's attention to, is the hardship caused to the ryots and inhabitants of the up Ghaut Taluq by the introduction of forest conservancy. The ways in which this system has affected our condition are too many to be fully enumerated now. It has thoroughly affected our live stock, which mainly constitutes our wealth. Our cattle have always been used to free and unrestrained grazing in the forest. Now that they are prohibited from entering the reserves, this mere restraint has tended to the death of large numbers. Until they become inured to the system of being tied up at one place, and fed there, even supposing that it were possible to do so, we must be losing our cattle in large numbers. The next difficulty is that of preventing these irrational beings from trespassing on the reserves. This, in fact, takes away a good deal of our time. The third difficulty is how to get fodder for these at home, and so on. It is a known thing that we generally take our meals, not in dishes and cups, but on leaves. In this country we depended on the leaves in the forests, and now this thing of our daily wants having been reserved, every soul is in a sad plight, when he goes to his meals. He does not see where to find leaves. It is no exaggeration to say that leaves for taking meals are

here being brought from the forests in such large quantities every day, that many poor old men and women, too old to do any hard work, used to go to forests to fetch some leaves for sale, and could thus pull on with their leaves. Now the conservancy system has deprived them of their means of livelihood, and the bulk of the poor inhabitants of one of their daily necessaries of life. We have laid some of our grievances, even of our pastoral and cottage life, so to speak, and trust that Your Excellency will graciously take these things into benign consideration and remedy the evil. We respectfully beg to conclude with an expression of our heartfelt thanks to your Excellency for the opportunity thus given us of submitting the sorrows of our heart directly to our Sovereign, as your Excellency is."

"Lastly, you speak about the forests. Well, gentlemen, I am sure the more intelligent of you do not imagine that all the dreadful things you speak of, are going to happen. Certain pieces of forest or jungle are in course of being turned into "Reserved Forest," after *full inquiry into and safe-guarding of all your rights. The simple* fact of the matter is that things had come to such a pass, that if Government had not stepped in, and said that certain forest must be looked after, and managed on a reasonable system, you would very soon have had no leaves, and no wood, and no grass. Things were going to rack and ruin, as fast as they could. I have been travelling for the last week or two, chiefly with a view to examine the forests, and to see what is being done about them, and I can assure you that I do not think we have stepped in an hour too soon. Utter destruction would very soon have stared all cattle owners in the face, and many other evil consequences would have arisen. Then, and very properly you would have turned on the Government, and asked why such wanton and wicked waste was permitted? To that question the Government could have given no answer. You will have plenty of wood land left to you where you can hack and hew to your heart's content, but the time will come (when unreserved forest has disappeared) that you will bless those who saved you from yourselves, and be uncommonly glad that the Government reserved certain portions of the forest from the general destruction to give you and your children fuel, and leaves and grass for your cattle, and a hundred other good things which, if we had allowed events to take their own course, would have been lost irretrievably."

The above extracts from an address to Mr. Grant Duff at Palmavér and his reply shows the great interest taken by the Governor of Madras in forest work in that Presidency. The complaints made by the people of Palmavér, in the North Arcot District, were mostly due to a misapprehension of facts. The proposed Reserved Forests are still under settlement, and a most careful enquiry into rights, especially rights of grazing, is in progress, though even with a vast amount of proclamation it is difficult to persuade people who have claims, to make them properly and get them properly enquired into.

The question of leaves for plates referred to is one which should properly have been made to the Collector, who will probably settle the matter himself. The leaves are those of the

'Moduga,' the *Butea frondosa*, and their collection is certainly not likely to do much harm even in the most strictly guarded reserves.

It is much to be regretted, in the interests of Forest Conservancy, that the Collector, Mr. A. J. Stuart, who has done so much for forestry, and taken such interest in the work of the Department, is shortly to retire. There are not many Civil officers in Madras who have done so much for forestry as Mr. Stuart, and all we can say is that we hope his successor will be as good a forester as himself.

The Governor has lately visited several of the forests and plantations in the Cuddapah and North Arcot Districts, and has, we understand, been much interested by what he saw. He has seen the Red Sanders in its native wilds and in plantation, the evergreen forests of the Pallampet valley, the rocky but still fairly well clad slopes of Horsleykonda, and the scrub jungles of the plateau of Madanapalle and Palmavér.

He has now gone to see the Forest Reserves of the Pulney hills, and in September intends to visit the teak forests of the Anamalais.

BEES IN THE PUNJAB.

At the Calcutta International Exhibition were exhibited specimens of the bees and honey of several districts in the Punjab, and the original district reports which accompanied the specimens have now been published by the Revenue and Agriculture Department of the Government of India. The bees exhibited were from Murree, Rawalpindi, Hazara, Multan and Bashahr. In Murree and Hazara bee keeping is largely practised by native villagers. The hive is a hollow cylinder of clay, varying from 8 to 20 inches in diameter, and proportionate in length to the thickness of the wall of the house in which the hive is to be kept. The hive is built into the wall, the outer end being closed up with exception of a small entrance hole, and the inner end being covered with a screen of clay and matting or board. The hive is prepared in April, and either a swarm is procured and shut up in it for a few days, or else the mouth is smeared with honey, *gúrh*, or *bhang*, by which a wild swarm is soon attracted. The comb is constructed in the course of 15 or 20 days, and in it the young bees are reared, becoming full grown in May, when they swarm off elsewhere, leaving the old bees in possession. These now begin to fill the combs with honey, a process which is completed by October or November, and finally, the honey is removed after opening the inner end of the hive and stupefying the bees with the smoke of burning cloth or tobacco or cowdung. The quantity of honey produced varies from 2 to 12 seers per hive, and the honey is prepared for sale by straining the mass of

combs through a cloth. Of the two kinds of bees the larger only are domesticated, except in and near Rawalpindi, where the small bee is kept in the same manner as the larger bee of Murree and Hazara. The small bees build their combs on rocks or trees, and are said to fill them both in the spring and in the autumn, producing young twice a year. In Multan only the small bees are found, but the District Report seems to show that these are of two kinds, one with stings and one stingless, and that the bees of both kinds produce honey. During the cold weather they hibernate in fissures of walls and trees, but for the rest of the year they work actively, filling their combs with honey both in spring and autumn. They are not domesticated or hived in any way, a fact due chiefly to the presence of numerous enemies in the shape of hornets, flycatchers and such like; and the bees seldom remain long in one place.

In the Bashahr hills near Simla five species of bees are known, of which only the *Yung* species is domesticated. The Yung resembles the common English bee, is easily hived and tamed, and produces a large return in honey and wax. It is only found in temperate climates and where the rainfall is sufficient, and its range is between 5,000 and 12,000 feet elevation. In the upper valleys of the Sutlej the Yung bees are domesticated in specially built houses, in the walls of which are numerous recesses, each with a small entrance hole on the outside. These contain the swarms, which are either attracted to the hive by rubbing it with a sweet paste, or are caught in boxes elsewhere and then brought in. Each house or collection of hives is placed under a man's charge, whose duties are to prevent excessive swarming, to keep the apiary well stocked, and to guard it from the attacks of bears, martens, hornets, wasps, and caterpillars. The honey is extracted in October after smoking out the bees, enough being left in the hives to support the bees during the winter. The yield of honey from an apiary often amounts to 50 pucka maunds, and large quantities are used in making an intoxicating liquor much consumed by the people of the neighbourhood. The other varieties of bees are not domesticated, but their honey is taken whenever found, and that of the Bungras or Humble bee is said to be of very superior quality. Bee keeping is largely practised also in Kashmir, and in some parts, especially in Lar, every native has several hives in his house.

A PIONEER OF FORESTRY IN MADRAS.

SIR,—Can any of your readers throw any light on the statement made by Sir George Birdwood in his note on the Indian exhibits at the Edinburgh Forestry Exhibition, which was as follows :—

"Before 1848 no check whatever had been imposed in India on the reckless clearing of the primeval forests for cultivation, and no heed was taken of the effect such clearing, particularly on the slopes of hills, would have on the rainfall. In 1848 Major-General Frederick Conyers Cotton, C.S.I., then a Captain in the Madras Engineers, urged on the Madras Government the necessity for taking some immediate steps to preserve the forests bordering on Coimbatore and Cochin from further denudation by the reckless wastefulness of the native contractors who farmed the forests for the supply of teak-wood for the Bombay dockyard. On his recommendation Colonel (then Lieutenant) Michael, C.S I., who had had opportunities of observing forest conservancy on the continent of Europe, and who, as an accomplished *Shikari*, had a wide practical acquaintance with the forests of Southern India, was appointed to give effect to General Cotton's proposals. Colonel Michael organised an establishment, opened out roads and timber slips down the mountain passes, and soon scored a financial success. His efforts in providing efficient conservancy were far more important. It became at once apparent that it was better in the interests of the State to preserve the magnificent natural forests of the Presidency than to raise an immediate revenue from them; and the first step taken in this view was to lease an extensive teak tract from the Zemindar of Colangode, and to buy up all his minor contracts with timber merchants. The whole of the Southern forests in the Madras Presidency, down to Cochin and Travancore, were thus placed, and have ever since remained, under strict conservancy. A system of clearing belts of brushwood to preserve the young saplings from fire was also introduced, the hill tribes being employed in the work; and in this way the destruction of the principal forests of Southern India was most opportunely averted.

"Within a few years the advantages of these measures, and the great success of Colonel Michael's work, were so clearly seen, that the Court of Directors, who had just then been so strongly impressed by the report of the British Association, sanctioned the extension of General Cotton's scheme to the remaining forests in the Madras Presidency, and, in short, inaugurated the organization of the regular forest department, not only in Southern India, but for the whole Indian peninsula and British Burmah. About the same time Colonel Michael, whose health had been undermined by seven years of incessant exposure to the dangers of forest life, when little was known about healthy or unhealthy seasons in the jungles, was forced to retire from his appointment, the work of which was taken up by Deputy Surgeon-General Hugh Cleghorn, M.D., as the first regularly constituted Conservator of Forests in the Madras Presidency."

It is curious that before this we have heard very little of the claims of Colonel Michael to be considered as the pioneer of forest work in Madras, and to 'have provided for an efficient conservancy.' So far as I have ever heard, Colonel Michael merely had a sort of roving commission to cut timber for the Public Works Department in the Anamali forests, and this he did, combining the work of felling trees with a considerable amount of 'shikar.' Perhaps, however, some of your readers can throw some light on the subject and tell us what the gallant

Colonel, who afterwards, when he got tired of shikar and the Public Works Department, held various employments under the Government of Madras, and especially that of Military Secretary, really did for forest conservancy. It sounds like a joke to find Sir George Birdwood saying that owing to Colonel Michael's energy 'the whole of the Southern forests of Madras were placed and *have ever since remained* under strict conservancy.' It looks very much as if a little mutual admiration society had been started at home, and it will be very interesting to ascertain facts.

ENQUIRER.

ENSILAGE.*

TO THE EDITOR, "INDIAN FORESTER."

SIR,—In November last I pitted some common grass in a pit made as follows :—

All of wood with false bottom and false sides, the space (8 inches) between the two bottoms was filled with saw dust, as were also the spaces (4 inches) between the two wallings. The box measured inside 4' × 4', and depth 6 feet. This was nearly filled with grass, and a weight of some 25 cwt. was put on top. The mass of grass sank very gradually, but continued sinking for a very long time.

The pit was opened on the 27th March. The top from 6 to 8 inches was bad, and the sides for about 1 inch.

The rest of the ensilage was in perfect condition, and was readily eaten by bullocks and ponies. I think this experiment will set at rest the question as to whether ensilage will succeed in this country or not.

TAVOY, BRITISH BURMA,
28th March, 1884.

CHARLES W. PALMER.

P.S.—I forgot to say that the pit was built under my house, and was therefore perfectly protected from all rain.

A VERY succcessful experiment in practical ensilage was recently made at Allahabad, by Major General Macpherson. The rank vegetation growing on a plot of grass land, about an acre in area, was cut down in August 1883, and packed in a pit dug in the ground 20 feet long, 10 feet wide and 8 feet deep. Continuous and heavy rain fell during the operation, and most of the grass was dripping with moisture when put into the pit. The

* We must apologise for the delay which has occurred in publishing this letter, which is entirely due to an oversight on our part.—[ED.]

III. Notes, Queries and Extracts.

Re-afforesting of Ireland.—Dr. Lyons, the junior member for the City of Dublin, sets a useful example to his fellow Irish members by the ardour with which he has thrown himself into the very practical subject of the re-afforesting of Ireland. Countries pass through several stages in the matter of forests. When a new region is being settled trees are treated as enemies. Not even the law of beasts of chase is granted to them. The sole thought is how soonest and most completely to destroy them root and branch. At a later period their value begins to be appreciated for fuel and building. Their fate is then harder than before. A colonist leaves them intact on the hills and wastes; lumberers and timber merchants pursue them relentlessly to their last refuges, and at length a day comes when the wood, hated or coveted, has all disappeared. Foreign timber is naturally dearer than home-grown by the cost of transit. Abroad the same ravaging agencies have been at work; and the foreign supply tends to become as scanty as the native. At this point a counter fashion often grows up, and timber is planted as an article of commerce to replace the indigenous forest. Towards the commencement of the present century many landowners in this island planted on a vast scale for profit. In Scotland Chief Commissioner Adam set the example, and Sir Walter Scott popularized it by his pre-eminent literary and social influence. A consequence has been that both in Scotland and in England woodlands continue to abound, though even here, in Sir John Lubbock's opinion, not at all sufficiently. In Ireland the character of the cultivation and the demand for land wrought havoc with the ancient forests, to which the huge deposits in the bogs testify. When more recently the tenure was occasionally modified, and some great proprietors looked to pastures and grazings for their returns, sheep and oxen proved as ruinous to the interests of timber as peasant farmers. Only in a few scattered instances was the improving and mercantile instinct among Irish landlords turned in the direction of new plantations for profit. There is, however, a third stage in the national views on forests; and some Irishmen, as some Spaniards and Italians, and many Germans and Frenchmen, have at last reached it. Observant men have discovered that forests are something better than obstructions to farming, or even than the raw material of window frames and railway sleepers. Where they have never

been known the land is found to be a desert; where they were and no longer are, or where they are ceasing to be, evidence exists that the climate has been changing for the worse and the soil been losing its richness. In Spain and Italy since the mountains have been denuded the streams have been less fertilizing in summer and more addicted to mischievous floods during the rest of the year. The extremes of cold and heat have been more violent. The productiveness of the ground has diminished. Dr. Lyons, Mr. Mitchell Henry, and other patriotic Irishmen, have noticed similar results in Ireland; and they trace them to the same cause. Re-afforesting is the latest panacea for Irish misfortunes; and it has more to recommend it than most of the other nostrums which have been proposed.

At the invitation of Dr. Lyons, though at his own expense, Mr. D. Howitz, who holds the office of Forest Conservator in Denmark, has been examining the resources and the need of Ireland for forest cultivation. He has surveyed its mountain ranges, its moors, its lakes, and its rivers. His experiences and conclusions he has embodied in a report to Dr. Lyons, which has just been published as a Parliamentary Paper. His deliberate judgment agrees with the surmises which had already been formed. Swamps and morasses are created in Ireland from the want of trees to drink up the superfluous moisture. Irish rivers inundate the districts they traverse because there are no forests on the mountain tops to arrest and retain the autumn and spring rains. In summer there is a dearth of water because the trees are gone which would have served, each, as a reservoir. A tree is advantageous in a double way; it is like a camel in its power of imbibing an enormous quantity when water is abundant or superabundant; like a camel it keeps the store for a time of scarcity. Irish agriculture, by its system of straight drains, which Mr. Howitz entirely disapproves, has acted as if water were poison instead of nutriment. In the past by felling the mountain woods, and in the present by planting no successors, it has done worse by tapping the supply at its source. Irish fruitfulness, he warns the nation, is gradually being drained and washed away into the lakes and seas; and no preparation has been made to replenish it. The folly is, in his estimation, the more inexcusable that the island presents the especial conditions for rendering forestry easy and beneficial. On the hills the soil is still able to feed all the trees which can be put into it. Out of the twenty million acres in Ireland he reports there are at least five millions for the most part waste, which might be planted with a reasonable certainty of profit. Irish wastes on the mountains and in the valleys are, he considers, of a different order of fertility altogether to the Landes, or the Pyrenean and Alpine slopes, on which re-afforesting is being conducted with indisputable gain. Ireland would, he is persuaded, grow valuable timber, instead of the commoner and cheaper kinds. A list

appended to his letter to Dr. Lyons enumerates 36 conifers, 38 deciduous and hardwood trees, and eight sorts of bushes, which could be grown to advantage. The varieties could be selected with regard to the readiest local uses for the wood. He has drawn up from personal inspection an elaborate scheme for planting a hundred thousand acres every year for the next 30. By the end of 30 years a plantation, he reckons, comes to full productive capacity, without respect to the previous incidental returns from brushwood and saplings. At 30 years of age he calculates that the cost per acre will have been at highest £20; the average annual profit at lowest he puts, at present prices, at a pound. Probably, as the demand for timber, of which England yearly imports two hundred and ninety million cubic feet, is rising, and the area of supply has been continually narrowing, the profit may be much larger. At present most of the five millions of waste pay not a penny of rent; the residue yields less than sixpence an acre. Mr. Howitz's business is to account for the alleged deterioration of Irish soil, and to explain how that propensity might be checked and the wilderness be utilized. He must be admitted to have executed his task very satisfactorily. How his plan is to be set going is a separate question, which the most skilful forester cannot settle. An Irishman's first and spontaneous assumption, when a means of enriching his country is suggested, is that the State ought to provide the capital. Mr. Howitz has accepted this doctrine from his Irish informants, and speaks of an advance of the necessary funds by the Government as if that were a thing determined. The one fund which could be employed for the purpose is the Tramways fund, which the House of Commons was good-humoured enough to vote in spite of financial protests. Many calls are being already made upon it, and it would hardly go far towards the fulfilment of the ambitious programme sketched by Mr. Howitz. But there are great Irish proprietors who might have the public spirit to make the experiment. On whatever scale the enterprise is tried, and however the expenditure may be arranged for, the re-afforesting ought at all events to be effected on a regular plan and principle. Mr. Howitz crowns his report by insisting that on all accounts a Forest Department will have to be established to control both the operations and the outlay.

Mr. Howitz is an enthusiast, as all pioneers in a good cause must be. He is inspired by his theme to pass an eulogium on the seclusion of the forests he exhorts Ireland to plant, the bracing purity of their future air, their freedom from formal restraint, the content to which they would shape the national mind. Certainly a delightful contrast is suggested in his report between the bare melancholy rocks, quagmires, heaths, and potato patches, which divide so much of modern Ireland among them, and a land of foliage and hanging woods. Eyes the most jealous of

encroachments on the indefeasible title of Irishmen to starve at home can scarcely spy out malice and covetousness in a design for reclaiming barren hill tops in a manner likely to benefit not more their capitalist owner than his cottar neighbours. In England, at any rate, where fewer susceptibilities have to be soothed, and the State need not be importuned for the requisite capital, it is strange that Sir John Lubbock's and Mr. Howitz's precepts should be slow in making converts. Throughout the country plenty of land exists unfitted for all cultivation except trees, and without a plantation upon it. Plantations in a region like England yield a rent, if not enormous, exempt from most of the caprices of climate, and gathered with no dependence on tenants and little on labourers. Of all sorts of landownership there is none with fewer vexations and with more exquisite enjoyment. But forestry is an art; and the fact has only been lately comprehended. Its inculcation would not have been necessary now had not Englishmen formerly imagined that they were all born with the knowledge, and been taught their error by sad experience. Tree cultivation requires an apprenticeship beyond farming, and as much as engineering. The planter plants for posterity more than for himself. His mistake, if he commit one, extends over 30 years, or more, and not over six months. His puny vegetable fabrics reproach their constructor's ignorance for a lifetime. Every man who plants a tree incurs a grave responsibility; but a sense of it should be a motive for correcting the ignorance which renders it burdensome, not for refusing the soil its rights.—*The Times.*

PROTECTION OF WILD BIRDS IN INDIA.—In a paper read before the East India Association, by Mr. Robert H. Elliot, on July 11th, occur the following remarks :—

Let me state the measures necessary for preserving the birds of India, and also for promoting their increase, in parts of the country where, from the absence of woods, but few birds at present exist. To attempt to frame a measure suited to the varying conditions that exist throughout our vast Eastern Empire, would entail so much discussion, and consequent delay, that the introduction of such an Act would probably be contemporaneous with the destruction of the last specimens of the bright-plumaged birds of India. It is obvious, then, that the only practicable course open is to instruct the subordinate governments to frame, and at once put in force, rules suitable to their own territories, as for instance, was done in the case of the early forest laws. As far as the people generally are concerned, there would be no objection to bird-preserving, for as we have seen in the case of the peasantry of Mysore, they are well aware of the value of birds as insect-eaters. After about a year from the date of the enforcement of preservative measures, the exportation of skins

and feathers should be prohibited, as this would most effectively aid in checking any attempt to evade the laws.

But to promote the increase of birds, and spread them throughout the length and breadth of the land, is not less important than to prevent their destruction, and in order to effect this, plantations should be formed on the waste lands of every village. Such plantations would at once shelter the birds, provide fuel (to the saving of the manure now used for that purpose), wood for building and agricultural purposes, shelter for grass and crops, promote the conservation of water, and effect a general amelioration of the climate. Let me now briefly allude to bird-preserving, from a revenue point of view.

On examining the return of exports and value of feathers and skins, we are at once struck with the fact that the Government has not only been so negligent of the agricultural interests of *India as to sanction the destruction of vast numbers of valuable* insect-eaters, but, in addition, has been so weak as to bestow on the exporters (I say exporters, as it is obvious that the bird-catchers get mere wages) of the feathers large sums of money which ought to have found their way into the Imperial Exchequer. The Government, as many of you are no doubt aware, preserves wild elephants, and derives from them a source of profit. On what principle, then, it may well be asked, has it given away a much more valuable product of our forests—bright plumaged birds? Had these been treated as State property—which they undoubtedly are—and had a close time been established, and a certain proportion of the birds been caught annually by the Government, comparatively speaking little harm would have resulted, and the State would have obtained an annual source of revenue. Now, of course, after the melancholy destruction that has taken place, even if the measures I have suggested were at once adopted, many years must elapse before it would be prudent to attempt to derive a revenue from the birds. But when they become very numerous (which they certainly will if plantations are formed as I propose), I see no reason why a revenue might *not be derived from them. We have remarked on the destruc*tion of bright-plumaged birds in other countries, and it is clear that as the work of extermination extends, the price of skins and feathers must much increase, so that it is almost certain that, at some future period, a small annual take of birds would yield to the State a considerable sum. To show what the Government has already thrown away or rather presented as a premium to the exporters, I may say that if the exports from the other ports at all correspond to those from Madras (and there is no reason to suppose that they do not), it would be a moderate statement to say that, within the last ten years alone, the State has sacrificed half a million of pounds sterling.

We have now seen that the advantage of birds is undoubted, and that their preservation demands immediate attention. Nor

have I ever heard but one objection made to preserving, and that was founded on incorrect information. It was alleged by the objector that to stop the destruction of birds would be to diminish the means by which wild, or hill tribes exist. So far as I can discover, such tribes do not destroy bright-plumaged birds. They are generally caught by Bhelias—wandering gangs of vagabonds, who plunder whatever they can find, and often make bird-catching a shield to other and more objectionable designs. Such vagabonds existed before the trade in feathers arose; they will equally continue to do so after its suppression, or after they themselves have abolished the trade by exterminating (which they assuredly will do if unchecked) the bright-plumaged birds of India.

Finally, let me remark on the need for establishing a close-time for the protection of game-birds. Every civilized Government preserves them, with the exception of that of India, which with two unimportant exceptions, allows them to be destroyed in any way, and at any season of the year. To act thus, is, of course, simply to extinguish a valuable source of food. The almost absolute extermination of game-birds (which live largely on insects, it may be observed) has already been accomplished in many parts of India. As to the rapidity of this extermination, I can myself bear witness, as Pea-Fowl, Jungle-Fowl, Spur-Fowl and the Imperial Pigeon, have been almost exterminated along the Western districts of Mysore. When last in India, I saw during a three months, visit one specimen of the Imperial Pigeon, which I regarded as a curiosity. The shrill call of the Jungle-Cock, once such a familiar sound, is no longer to be heard, and the extermination of this bird has been accomplished with a completeness I could never have credited had I not had ample opportunities of observing the fact. Towards the close of last and the beginning of this year, I drove through upwards of one hundred miles of woodland without seeing a single specimen, though I may mention that one was seen by my servant. As regards Pea-Fowl, from inquiries I made from the natives, not a specimen is supposed to exist in the neighbourhood of my plantations and for many miles around. I can only regard it a folly and a crime thus to permit the extermination of game-birds throughout the land. Had a close-time been established they would have yielded annually-increasing supplies of food, and, in the case of some of them, valuable feathers. But I have probably said enough to show that game-birds, as well as birds sought solely for their plumage, ought to be placed under the protection of the State.

Prompt attention is needed in order to extend throughout the length and breadth of India those woods which are necessary for the use of man, and birds, and the amelioration of the climate. Not less attention is required to preserve and promote the increase of those birds which so largely aid in

preventing an injurious increase of insect-life. Let us, then, do what we can to represent the cause of nature, and endeavour, on behalf of the beautiful and useful wild birds of India, to bring about a measure for the restoration, and preservation, of that balance of nature which has been, and is now being, so grievously injured by the negligence of the Indian Government.—*Pioneer.*

TIMBER FOR TEA BOXES IN CHINA.—The *Ceylon Government Gazette* contains further Consular Reports on the timber used in different districts of China for tea boxes. Mr. J. P. Hughes, of Shanghai, stated :—

The tea chests made at Shanghai are comparatively very few in number, the great bulk of the tea being packed in chests made in the interior. The wood generally used in Shanghai is a sort of pine known as "Shanmu," probably the *Cunninghamia sinensis.* It is chiefly imported from the Province of Fokien, and is different from that used for the tea chests at some other parts in China. The wood is cut into suitable lengths and stored in a dry place for at least a year, and sometimes two years, before use. Green wood is rarely used, as it invariably injures the tea, causing a distinct pine flavour known in the trade as "woodiness." I am informed that this flavour has never been found in Congou tea, but occasionally in the kind called Ping Suez. Tea is packed up-country generally in chests made of the wood of the "Fung" tree, by which name maple is generally understood, but it also applies to the Liquidambar. More precise information on the subject of country-packed tea will no doubt be supplied from Hankow and Kinkiang. The storing of the wood in a dry place for at least a year, no doubt, deprives it of the objectionable turpentine odour, which itself is far less prominent in some pines than it is in others. But Consul Oxenham of Chinkiang reported :—

The result of enquiries shows that the willow tree most commonly furnishes the wood used in China for making tea chests. It is cheap and abundant, is easily sawn into boards, holds nails well (not splitting when they are driven in), and does not exercise any corrosive action on the lead lining of the chests. Pine wood, which is equally cheap, has been also tried, but is found to be unsuitable for the purpose: it does not hold the nails, splits easily, is liable to exude turpentine and injure the lining, and when new shrinks and cracks.

Other woods, such as the chesnut and Huai or locust tree (*Styphonlobium*), are also equally available for the purpose, but are generally too scarce and dear to be much used. In a few places, however, where such trees are abundant, they are occasionally used, but never for long, as they are valuable both for ornamental and edible purposes. Now if by "willow," the or-

dinary willow is meant, we fear the information will be of little practical use to us here. But the "willow" in question may be a tree suitable for growth in Ceylon, and we have no doubt Dr. Trimen will address himself to this subject. We cannot forget that Mr. D. Morris of Jamaica wrote of *Ficus Benjamina* as "the Ceylon willow." Consul Jamieson of Kinkiang reported :—

I am informed that the wood universally used in this district for the above purpose is that known by the natives as the *Fung* tree. The Fung appears to correspond to the genus *Liquidambar*, of which there are several varieties. I am unable to say which is the more common in this neighbourhood, but all appear to be available for tea packing, the recommending feature being that this wood imparts no flavour to the tea. A large proportion of the best teas is exported from Kinkiang, the chests for which have all been manufactured locally for many years, and I have never heard complaints of any corrosive action on the lead lining.

Finally, we have a report from Officiating Consul Foster of Tamsuy, in favour of pine, thus :—

Seasoned common pine from the mainland portion of the Fokien Province is the wood most generally used within this Consular District for making the chests in which tea is exported to foreign countries.

Note that the pine is well-seasoned.

The *Gazette* contains a correspondence on this subject. Writing to the Colonial Office (London) on 29th March, Mr. Thiselton Dyer states :—

Sir Joseph Hooker would remind you that *Pinus sinensis*, the wood of which is apparently largely used by the Chinese for the purpose, answers extremely well for plantations in Hongkong and on the neighbouring Chinese mainland, and it has been recently introduced by His Excellency Sir J. Pope Hennessy into Mauritius. It is worth consideration whether its experimental cultivation might not be attempted where suitable land is available in Ceylon.

Mr. Thiselton Dyer had written to the Foreign Office in November 1883, as follows :—

I am desired by Sir Joseph Hooker to inform you that enquiries have been addressed to the Royal Gardens from Ceylon as to the nature of the wood used in China for making the chests in which tea is imported into this country. It is a matter of considerable commercial importance, as in some cases Indian Tea has proved irretrievably damaged on its arrival in this country owing to the corrosive action of the wood on the lead lining of the chests. The tea has consequently been unprotected from damp, and has further been deteriorated by a flavour communicated by the wood.

Under these circumstances, Sir Joseph Hooker is of opinion that it would be well worth the trouble, if the Secretary of State

should think fit to invite Her Majesty's Consuls in those parts of China from which tea is exported, to inquire into the matter and report, as far as they are able, as to the nature of the wood most generally in use. Perhaps the attention of Dr. Hance, whose knowledge of Chinese botany is so extensive and accurate, might be particularly directed to the question.

The reply from the Foreign Office on 28th March, 1884, was :—

With reference to the letter from this Department of the 5th of December last, I am directed by Earl Granville to forward to you herewith, for the inspection and use of Sir Joseph Hooker, a sample of the wood that is said to be exclusively used at Foochowfoo for making the chests in which tea is exported thence to this country.

In forwarding this sample, Her Majesty's Consul at that port states that it is the common pinewood of China (*Pinus sinensis*), and is produced principally in Tingchowfoo, a prefecture of the province of Fuhkien in the north-western direction, several hundred miles to the north of Foochow, where timber of this description grows in great abundance and is brought down the Min river in rafts, like those seen on the Rhine.

Mr. Sinclair adds that this wood is also greatly used for coffins in preference to any other on account of its consistency and durability.

Now if *Pinus sinensis* can be grown in Mauritius it can doubtless be grown in Ceylon. But if it is to compete with our suitable indigenous woods, it ought to grow readily and quickly. Perhaps Dr. Trimen can give some information about it? We have sought in vain for any notice of *Pinus sinensis* under that name. It does not seem to have been introduced into India?—*Indian Agriculturist.*

HEALTHFULNESS OF FORESTS.—A mountain cliff, a wall, or a forest, are the natural protection against the wind. In this respect the forest can not be without beneficial effect on the adjacent country; the young growth of trees flourishes, screened from the force of the wind, the arable land develops itself better, sands meet an impassable barrier, and the noxious influence of the dry winds is turned aside. It is, then, indisputable that the forests exercise a salutary influence on the temperature of a country. The sanitary condition of man and the domestic animals, as well as the growth of cultivated plants, depends on the climate of the locality. The fertility of a country depends on its supply of forest land; for on this depend the foundation of soil, the precipitation of dew, the fall of rain, the steady current of rivers, the mitigation of the evil influences of unhealthy winds, and the growth of vegetables in the fields and meadows.—SCHACHT.

Italy.—When the Apennine and Sabinian Mountain range and its slopes were covered with its natural growth of trees, the now detested Roman Campagnas, which constitute the largest part of the Pontine swamps, were a beautiful section of country. They were then adorned with sumptuous summer residences, villas, parks, flower and fruit gardens of the Roman aristocrats After the destruction of the forests, the whole region became unhealthy, and almost absolutely uninhabitable on account of the malarious gases emanating from the soil. Formerly, these were absorbed by the leaves of numerous trees; now they fill the air and infect even the very heart of St. Peter's eternal city. Within a few years a portion of these swamps have been planted with eucalyptus trees, and they have had a wonderful effect on the healthfulness of the atmosphere, and people now reside in these parts during the summer, where but a short time ago it was impossible to live. The eucalyptus tree is now being introduced into the everglades of Florida in order to purify the air in these unhealthy regions of the State.—PHIPPS.

Hanover.—In Hanover, a province of Prussia, there are 600,000 acres in the government forests, and the cost of working and all expenses, £130,000 annually; the receipts £300,000, and the profit £170,000. Here the steepest and most rocky sides of the hills are all covered with forests, which have been created by the labors of the Forest Department. In many such places, where even the few handfuls of soil placed round the young tree had to be carried some distance, it is not contended that the *first* plantation will yield a pecuniary profit, but the improvement in climate by the retention of the moisture, and the reclamation of large tracts, formerly barren and unproductive, is taken into account; besides which the dropping of leaves and needles from the trees will, ere long, create a soil and vegetation, and insure the success of plantations in future years.—PHIPPS.

Immense amount of Water given to the Atmosphere by Trees.—The amount of moisture given out by trees is immense. In some trees the upward rush of moisture from the roots is very powerful. The workmen in ship-yards frequently find in the centre of a teak log a core of sand 50 or 60 feet long, an inch in diameter, and hardened to a marble-like consistency, which has been carried and deposited there by the sap in its upward course.

A few years ago a number of scientists of New England made a calculation as to the amount of water given to the atmosphere by the "Washington Elm," Cambridge, Mass. They calculated that the leaves of that tree would cover over 200,000 square feet of surface, and that they gave out every

fair day during the growing season 15,500 lbs., or 7¾ tons, of moisture.—J. B. PEASLEE.

The Rain and Forests.—There is nothing of greater importance to the agriculturist than rain at the proper season and in proper quantity; and science has demonstrated that the forests of a country are potent in the regulation of storms, the formation of clouds, and the descent of rain. Any thing which vitally affects the interests of the farmer and producer affects the whole State, and demands the earliest attention of the people's representatives.—*New York Report of the Commissioners of State Parks.*

The Pine Tree.—

Old as Jove,
Old as Love,
Who of me
Tells the pedigree?
Only the mountains old,
Only the waters cold,
Only moon and star,
My cöevals are.
Ere the first fowl sung,
My relenting boughs among,
Ere Adam wived,
Ere Adam lived,
Ere the duck dived,
Ere the bees hived,
Ere the lion roared,
Ere the eagle soared,
Light and heat, land and sea,
Spake unto the oldest tree.

—EMERSON: "*Wood Notes.*"

The tremendous unity of the pine absorbs and moulds the life of a race. The pine shadows rest upon a nation. The northern peoples, century after century, lived under one or other of the two great powers of the pine and the sea, both infinite. They dwelt amidst the forests as they wandered on the waves, and saw no end nor any other horizon. Still the dark, green trees, or the dark, green waters jagged the dawn with their fringe or their foam. And whatever elements of imagination, or of warrior strength, or of domestic justice were brought down by the Norwegian or the Goth against the dissoluteness or degradation of the south of Europe were taught them under the green roofs and wild penetralia of the pine.—RUSKIN: "*Modern Painters.*"

PIPES.—The short clay pipe formerly used by smokers has of late years been to a great extent supplanted by the wooden pipe, the manufacture of which is now an important industry. Some interesting information respecting these pipes is given in Consul Inglis's trade report on Leghorn, whence the material for making wooden pipes is now largely exported. Similar works are also to be found at Siena and Grosseto. Selected roots of the heath (*Erica arborea*)—preference being given to the male variety—are collected on the hills of the Maremma, where the plant grows luxuriantly, and attains a great size. When brought to the factory the roots are cleared of earth, and any decayed parts are cut away. They are then shaped into blocks of various dimensions with a circular saw set in motion by a small steam engine. Great dexterity is necessary at this stage in cutting the wood to the best advantage, and it is only after a long apprenticeship that a workman is thoroughly efficient. The blocks are then placed in a vat, and subjected to a gentle simmering for a space of twelve hours. During this process they acquire the rich yellowish-brown hue for which the best pipes are noted, and are then in a condition to receive the final turning; but this is done elsewhere. The rough blocks are packed in sacks containing forty to one hundred dozen each, and sent abroad, principally to France (St. Cloud), where they are finished into the famous G.B.D., or "pipes de bruyère," known to smokers in England under the name of "briarwood" pipes. The production of this article is considerable, four hands turning out about sixty sacks per month. Consignments are also made to England and Germany; but, the Anti-tobacco Association will be glad to hear at present the demand is said to be rather slack.—*Timber Trades Journal.*

AUSTRALIAN TIMBERS.—It has repeatedly been asserted that Australia is deficient in timbers suitable for building and other industrial purposes, but the assertion is utterly without foundation. On the contrary, the various colonies, especially New South Wales, are rich in timbers of every possible description, many possessing a beautiful colour and grain, rendering them eminently suitable for decorative woodwork. Among the more plentiful of the New South Wales timbers are the following:—Ironbark, generally used for railway purposes and girder beams for buildings. The retail price is 2*s.* 6*d.* per cubic foot for girders, and £1 5*s.* per 100 superficial feet for sawn timber. Grey gum, generally used for building purposes, palings, and fencing, and is retailed at 18*s.* per 100 superficial feet. Marsh box, generally found in rich marshy ground, and is used for building purposes; price 18*s.* per 100 superficial feet retail. Blackbutt, greatly used for all kinds of house and ship-building purposes, and also for street-paving cubes; price 18*s.* per 100 superficial feet. Spotted gum, mostly used for shipbuilding,

owing to its long lengths and bending qualities; price 18*s*. per 100 superficial feet retail. Mahogany, used for fencing and general purposes, is considered to be able to stand a long time under ground; price 18*s*. per 100 superficial feet retail. Tallow-wood, one of the best timbers for building purposes that can be obtained in the Colonies, having a greasy nature resembling Indian teak, and sells at about the same price as ironbark. Blue gum, greatly used by wheelwrights, and also used for general purposes, and belonging to the best class of timber growing in this colony; price 18*s*. per 100 superficial feet retail. Colonial pine is largely used for all rough purposes in house building and box making, and also for flooring boards, and sells at present at £1 2*s*. per 100 superficial feet retail.—*Timber Trades Journal.*

GAMBLE'S INDIAN TIMBERS.—Mr. Lowrie has written to point out that in Ajmir *Cordia Rothii* has a heartwood, and that in *C. Rothii* and *C. MacLeodii* the rings of the heartwood differ from the annual rings.

These facts are not given in Mr. Gamble's book on Indian Timbers. We shall be glad to receive specimens of these woods from Mr. Lowrie for the Dehra Dún Forest School collection.

WE have noticed a resolution of the Government of India dated the 16th of August, under which it is ordered that all officers drawing a pay of Rs. 250 and over, whether gazetted or not, are entitled to the gratuitous medical attendance at their own residences from Civil Surgeons, and that gazetted as well as other officers drawing less than Rs. 250, are not entitled to gratuitous medical attendance, except in the case of Probationers under the Statutory Civil Service Rules, and Assistant Superintendents of Police drawing less than Rs. 250 a month. It is a great pity that Sub-Assistant Conservators of Forests were not included in the list of exceptions, considering that by the nature of their work, they are specially exposed to malaria and other causes of disease.

WE hear that Messrs. Shuttleworth, Fry, Fuchs, Mainwaring and Wroughton of the Indian Forest Department, are serving as jurors on the Edinburgh Forestry Exhibition.

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THE BABUL MEADOWS OF THE SHOLAPUR DISTRICTS.

(Concluded from page 399.)

CHAPTER III.

Babul Plantations.—I shall now proceed to give my experience as to the various artificial methods of rearing babul meadows. The following methods have been tried by me in several places in the "reboisement" of the Sholapur District—

1st. Broad-casting the seed.

2nd. Dibbling seed into prepared pits or unprepared ground.

3rd. Plough lines of a few feet breadth and from 6 to 12 feet apart.

4th. Ploughing, harrowing and sowing the land as for an ordinary crop.

Broad-casting.—Of the first system I have but little to remark, it is a very simple and at the same time a very safe system if the soil is fairly good and the land rigorously closed, but it does not show quick returns, and can not be looked upon as a plantation in the strict sense of the term. Broad-casting, however, is a good and safe system I repeat, and may be employed advantageously on semi-denuded as well as entirely denuded areas. It also is of great use in assisting natural regeneration under old reserves.

Dibbling.—I cannot say as much for the second system. I have found dibbling succeed fairly well in semi-denuded forest lands, scrub jungles, and in gaps of young plantations worked on the fourth system. I have never seen it a success in bare and exposed lands. In fact I am thoroughly convinced that dibbling on those waste lands which have not a tree to afford shade or protection from the wind, sun and other climatic and meteorological influences, is a waste of labour and money. And as we have in the Deshi talukás about 90 per cent. of our forest land

to reboise, to do it in this way is useless. I may be wrong in my inference, but the above is a fact. The cause I believe is this. The system only permits of a few seedlings springing up together in bunches, so far removed from another that they in no way hasten the growth of the fittest, or protect each other from the climatic and other influences above noted. If transplanting fair sized seedlings of babul were possible, it might be otherwise, but this mode of plantation is impossible.

Plough lines.—We come to the third system, *viz.*, sowing seeds in plough lines of varying breadth with an intermediate space of a few feet. From the operation of ploughing alone it is precluded from semi-denuded forest lands and scrub jungles, of which the Sholapur District has a great amount, and must be confined to entirely bare lands, as the damage done by the plough and animals drawing it is unavoidable. On denuded lands I have found that it is but of doubtful success, owing perhaps to the intermediate blanks which render it open to the same drawbacks as dibbling when employed on open and bare tracts of land. I cannot say that I have not seen it succeed, for it has succeeded, but a neighbouring fringe of trees or an extraordinarily fertile soil with plenty of moisture has been the accessory to the success. The broader the plough lines the greater the success, and consequently I am led to the belief that it is best to plough the whole area and go in for the fourth system, which is "par excellence" the best way to rear babul for *a quick return.*

Entire ploughing.—The fourth system must necessarily be carried out on lands which are entirely bare of lignified forest growth, as the whole land has to be ploughed over. It is no use, in the face of the enormous bare areas existing, rushing to a semi-reboised tract of land and there introducing the system, though I would not absolutely deprecate clearing a piece of waste land required for a fuel reserve in a certain locality near a railway station or town, or for any other special purpose. For the sake however of the general principles of reboisement I think the best land to choose for this species of plantation is a bare piece of land of the deep black cotton soil, or the sandy deposits *found on the river sides. Having fixed this kind of land as it* gives the quickest and largest revenue hereafter, it should be ploughed and cross ploughed in the months of December and January, it should then be cleared of all grass and roots. This rubbish should be piled in heaps and set fire to. The ashes can then be scattered over the ground or left where they are, for their quantity is very insignificant. The ground should be harrowed once and even twice, as I find the more the soil is worked the better are the results.* If the soil be only indifferently

* Well ventilated soil is invaluable for babul plantations, and I would say indispensable. One has only to see the results on the ballast of newly formed lines of railway, *e. g.*, Dhond and Manmad. The Resident Engineer at Sholapur showed me a wonderful example of germination and growth of this nature.

worked, the growth, if it ever appears, is poor, similar to that of the former systems, and gets choked in spite of any amount of weeding. This naturally leads me to infer that the babul seedling demands a large quantity of one of the constituents of the atmosphere, and that it does not wish to divide nourishment with any ranker vegetation, as it invariably gets the poorer share, and cannot therefore grow as rapidly as it might. It is true that young babul seedlings grow very well with certain other timber tree seedlings, but not with rank weedy vegetation.

After harrowing, the drill plough, as used for jowari in the Sholapur District, should be brought into use with the first showers in June. The lines of seed should be as close as those used for the above cereal, and the seed should be sown very thickly. The thicker the better, for as soon as the first branchlets meet, the possibility of grass and weeds growing is minimised, and from this point the growth increases most rapidly.

Best seeds to be used.—It will be necessary to notice here that the seeds should be obtained out of some neighbouring sheep pen, as they germinate and also grow the quickest of any during the first year. Seeds soaked in water for 24 hours at about 200° F. are often used, but they, as well as others subjected to other fantastic processes, are not to be relied on, as they do not germinate at once in even tolerably reliable quantities, consequently many places are left in a bare and clear condition, and that the growth of such a plantation is slower is at once evident.

Weeding.—In ten days or a fortnight from sowing, the seed should have germinated and sent up its two primary leaves, and within a fortnight of this, or one month at the latest, a first weeding will be found necessary. This will generally be about the middle or end of July, nothing more will be needed if the germination has been tolerably successful. However, even in tolerably successful cases a second weeding should take place in October; when, given that the plantation is on the good soils above referred to, the seedlings should not be less than 2 feet in height. They will sometimes be as much as 3 feet. *This second weeding has the effect of loosening the upper* soil, caked by the heavy showers of the monsoon, and of permitting air to reach the roots, thus giving a spur to the growth, which is remarkable during the cold weather. I have known cases where it attained 6 feet in height by March. The growth then seems to rest until the next monsoon, when it again shoots upwards, arriving at its second and third monsoon at 10 and 14 feet respectively.

Thinning.—At the end of the fourth or fifth monsoon it will be found that the growth has passed the foliage height, and *is about 20 to 25 feet. This is the time to make the first thinning.* The small babuls which have succumbed in the struggle can then be cleared out and used for fencing or fuel purposes.

Besides this, 5 candies of living trees per acre can be cut out for cart shafts. The thinning should not be carried out too hardily, as I have found that babul grown quickly, as I am now explaining, will, if too strongly thinned at first, be easily blown down. The first thinning should therefore spread over the fifth and sixth years of its growth. In the fifth year as stated above 5 candies, or $1\frac{3}{4}$ tons, can be removed per acre. In the sixth year 15 candies, or $5\frac{1}{4}$ tons. After this the plantation should stand quiet for about 3 years.

In $5\frac{1}{2}$ years 7 tons of wood have been cut out per acre, and I estimated in one plantation near Barsi, of exactly one acre, that the remaining wood weighed about 50 candies, or 18 tons; from which I drew the inference that under especially good circumstances of soil such as the above, that $4\frac{1}{2}$ tons per acre and per annum was the average yield for the first 6 years. It cannot, therefore, be expecting too much to place the average annual yield at 5 tons per acre and per annum, for the term of the babul's prime say of 45 years.

Now 5 tons per annum would, at Rs. 4 per ton, price in forest, bring in Rs. 20 per annum and per acre; or in 45 years one acre would yield Rs. 900; but this sum cannot be looked upon as the clear profit. The following amounts must be deducted from it to arrive at the net profit:—

	RS.	A.	P.	RS.	A.	P.
Rent of 1 acre best cotton soil (jirait) lost to Government by being in forests, @ Re. 1 per acre for 45 years, ...				45	0	0
Cost of plantation per acre—						
Ploughing and harrowing, ...	9	0	0	15	0	0
Sowing, ...	1	8	0			
Weeding, ...	4	8	0			
Cost of temporary fence of thorns for two years, to protect permanent quick fence, of an average 700 feet per acre—						
Per 100, @ Rs. 2 first year, ...	14	0	0	21	0	0
,, @ Re. 1 second year, ...	7	0	0			
Cost of quick fence, @ 8 annas per 100 feet, ...				3	8	0
Thinning the same every 3 years, for 45 years, @ 8 annas per 100 feet, ...				52	8	0
Cost of felling 5 × 45 tons, @ Re. 1 per ton, ..				225	0	0
Cost of supervision inappreciable.						
Total outlay, Rs., ...				362	0	0
Net gain, Rs., ...				538	0	0

This gives as nearly as possible Rs. 12 per acre and per annum after paying all costs. It will be seen that the very

largest estimate possible is made for expenditure. The ploughing, &c., will never in any soil exceed this cost. The fencing I have calculated as being required on two sides of a special acre of 2 guntar by 20 guntar, a very unlikely event when some 30 or 40 acres are being treated in this way.

It might be argued—why do not the natives take up a cultivation yielding so much? The fact is, they cannot afford the outlay in the first place, nor could they wait so long for a return, for it is naturally in the latter years of the babul's growth that the revenue makes the average so high.

Mr. Morarji Goculdas, late Member of Council, consulted me on the point of revenue from babul, and he was convinced, that it would be paying in the end, so for the purpose of supplying his weaving and spinning mills at Sholapur, he bought up suitable lands and commenced plantations on the plans I explained to him. Since his sudden death in 1880, the work which was at first pushed forward energetically has relaxed, and results are not satisfactory, but this is no matter of surprise, when as I understand, the revenue from sheep grazing among the babuls is a temporary prize, that the present agents of the mill cannot forego.

Associates to Babul.—I have said nothing of associating other species with babul in plantations. I have hitherto strictly adhered to a pure babul plantation on the richest soil, but circumstances arise when the best soil cannot be obtained, or that parts of the soil are suitable to babul pure, and parts are not.

Effect of Soils on species.—I have found that if the black soil gets shallow in parts, the best thing to do to insure success, is to mix bor (*Zizyphus jujuba*) with the babul seed, the growth of the babul does not appear then so stunted, as when it is by itself. Should the soil be extremely shallow, and the murrum crop out in parts, the babul may just possibly be able to grow here and there amongst bor, sirris (*Acacia odoratisima*) and ním (*Melia Azadirachta*); these latter grow remarkably well on the shallowest soil covering murrum.

Again, the soil may change from black to the calcareous white soil. Babul will never do anything here, but the above named species thrive uncommonly well, with the exception of the bor. Therefore in making babul plantations special attention should be paid to the changes of the soil, &c., in order to prevent gaps and breaks. This can be done, by having at hand a certain quantity of the three above named species as associates to the babul.

Further remarks relating to para. 34.—I strongly deprecate, except for general objects of reboisement, ploughed plantations in strips.

In the *1st* case, the whole soil is not utilised, and the preparation is really a very small factor in the cost.

2ndly. A very large quantity of the trees on the outer edges

of the strips grow extremely crookedly, and as they receive the most light, they are invariably the largest in diameter. They consequently damage the straighter ones in the centre of the strips by cramping, and in many cases eventually killing them. It is extremely injudicious to cut these outer trees, owing to the large gaps they make, hence the death of the centre and straighter.

3rdly. The system is not natural, one never sees natural growth in strips.

4thly. The labour of weeding is greatly increased during the first year, owing to the vegetation between the strips.

5thly. The soil is not ventilated enough.

Value of Babul in Forests.—The average prices of wood in the different talukás of Sholapur varied very much whilst I was in the Districts. It sold in 1881, in the forests of the

Sholapur taluká	for	Rs. 2-8	per candy	of	784 lbs.
Barsi	„	Re. 1	„		„
Madha	„	„ 1	„		„
Karmala	„	„ 0-12	„		„
Pandharpur	„	„ 1-4	„		„

In the Nagar Districts the prices attained in the forest reserves for the year 1883 were—

For	Nagar Taluka,	...	Rs. 1-6-0	per	784 lbs.
„	Shrigondeh „	...	„ 1-9-0	„	„
„	Sheogaon „	...	„ 1-4-0	„	„
„	Rahuri „	...	„ 1-8-0	„	„
„	Kopargaon „	...	„ 1-0-0	„	„

Chapter IV.

Cuttings in Babul reserves.—Having shown thus far the best means of procuring a good babul meadow, and how it should be treated up to 6 years of age, I will now proceed to show how the same tract of babul should be treated up to maturity.

I have said in the sixth year, that a thinning of about 15 candies per acre should take place. The choice of trees is here a very delicate operation, for on those that are left depends the maximum growth being kept up. This is obtained by reserving as much as possible all the young trees that show a marked increase of growth over their associates.

State of reserves after thinning.—Care should be taken in cutting out the thinnest stemmed trees, that no large gaps are caused. The heads of the reserves should be so far freed, that they become clearly separated from one another and do not

touch, unless moved by a tolerably brisk breeze. When the thinning is finished the sunlight ought to be seen on the ground in a regularly diffused manner, and not in large patches.

Cleanings during thinning for benefit of the associate species.—At the thinning in the sixth year, it will be often found necessary to assist ním and sandal trees in the reserve, for they are more valuable than babul, and generally found associated with it. They will have been passed in growth by the babul whether sown at the same time, or germinated in its shade from seeds dropped by birds. Though they will grow for a certain time in its shade, they will, if not freed at the sixth year, stop growing altogether, or grow in such a way as to unfit them for future use. Therefore the babul trees immediately covering them must be cleared out without hesitation, leaving them a good sky hole to escape by. This is the only case in which a large gap in the upper growth should be made. The gap will be closed before the next thinning, which should be in the ninth or tenth year at the latest.

Choice of trees to fell in thinning.—From the above it will be seen that in thinning the following trees should fall :—

1st. Those that show the least signs of longevity and strong growth.

2nd. Those dominating the more valuable species, such as ním and sandal. Besides these the following trees should also be chosen in preference to others for the axe.

3rd. All trees that have been seriously injured and which are showing signs of any physical decay. These signs can be at once detected by ascertaining whether the tree has ever been barked or had a principal branch broken.

4th. All dead trees.

5th. All trees that have been blown down or bent over beyond the power of recovering their position. One exception must be, however, quoted here to this rule, and that is, when such trees are on the outer edge of the reserve, be it by a river or any other open side.

In the 1st case these trees act as a safeguard against erosion of the soil, and prevent the inner trees from being in turn uprooted and bent over.

In the 2nd case it is most essential to preserve them, as they act as a strong curtain against the wind, which if it got easy access to the interior would certainly not fail in blowing down a great number of other trees, especially in the earlier years of their growth, when the great object is to obtain a good length of straight stem before developing the lateral branches.

Term and period of Thinnings.—Thinnings of this nature should take place once every three years, until the trees have

obtained say 30 years' of age. After this age, until the trees are commencing to show signs of having lived their life, once in 5 years will be quite sufficient. The signs that indicated their age, I have always noticed were the re-appearance of a very general growth of the young babul under the elevated cover of the older trees.

When the above took place, I did not adhere to the usual method of regeneration as taught in Continental Schools, because babul does not coppice, so I left the seedlings on the ground, clearing away the reserves in the annual fellings by degrees, thus allowing the young trees space in which to grow, the results were not a regular growth, as some parts seeded sooner than others. But with care and an eye to keeping the best seeding trees where they are required for filling up gaps, a complete irregular growth can always be obtained.

Treatment when regeneration is complete.—Once the old reserves are all cut out the young growth grows into a dense thicket, which, when it has passed what is termed its height of foliage, will again be open to the axe.

General Remarks.—It is needless to say that I have not formed the above opinions on the same piece of babul forest from youth to maturity, but I have had ample cases of all ages to build my inferences on. The only drawback in this is, that I am unable to give any figures as to the amounts obtained at the various trimmings and fellings, as I have shown up to the sixth year ; this is entirely owing to the absence of any data to guide me as to the origin and previous treatment of these reserves. Some places were too restricted, and open to the various influences of an irregular growth. Others again showed trees approaching death at about their 26th year, and yielding very little timber per acre. This amount of course could not be taken, as the amount that might be cut off the ground from the time when regeneration has set in, to the time when the last reserve is felled. Also what the triennial and quinquennial thinnings will yield can only be determined when it is absolutely certain that one is making such a thinning, and not a thinning merely in continuation of some desultory kind of haphazard hacking that may have taken place two years before or ten. Had I remained in the Sholapur Districts, I might have been able to give accurate figures up to the end of the rotation, but this was out of my power. Somebody else may hereafter fill up this gap. But I certainly think the treatment above pointed out will ensure regeneration.

Babul felling by digging.—As to the best means of felling the babul. This tree cannot be said to be actually felled, it is at first dug up as far down as the tap root gives timber. The lateral roots are then cut through, and a push from the feller sends the tree to the ground. This style of felling is, however, only applied to trees when they attain 8 inches to 9 in-

ches in circumference, under this size they are felled level with the ground, the root timber not being then worth the trouble of extracting. Some large trees have to be dug down 8 feet before sufficient root is cleared, and it has cost as much as Rs. 5 to fell one tree, but then the tree yielded Rs. 60 in revenue.

Occasions present themselves often where it is best, especially with the larger tree, not to dig out the root, viz., when the tree is growing on a steep bank or on land open to floods or erosion.

Babul barking.—Where there is a large town in the vicinity of the reserve, it is very profitable to bark the babul and place the bark under cover. Tanners will give as much as Rs. 8 per candy of 784 lbs. for babul bark when fresh. If left on the tree it sells for its weight in wood. The barking, in spite of the dry climate, never seems to damage the wood by splitting.

Precautions in fellings.—In felling babul, care should be taken to lop such branches first, as will permit of the tree falling in a desired direction, viz., not to injure the surrounding or inferior growth, if any such exist, and has to be preserved.

Disposal of the smaller branches for fuel.—When the tree has fallen, the quick branches should all be lopped off and stacked for fencing sticks. Then the slightly larger branches, up to say 6 inches diameter, should be lopped off and cut into fairly straight lengths, which should not exceed 10 feet, over this they become cumbersome to place in carts. For if the contractor finds he cannot remove the fuel without cutting it up on the spot, prices suffer. These branches, which are only of use for fuel, should be stacked in heaps neatly and squarely. Any fixed dimensions for length, breadth and height are not necessary, but the stack should be neat and compact, as the weight can then be calculated to a certainty. I generally allow that 45 cubic feet fair packing, makes one candy of 784 lbs., but if all the branches are very large, 40 cubic feet is nearer the mark.

Disposal of larger branches for fuel or timber.—The minor branches and thorns being now stacked, it remains to cut off the principal branches and number them separately, as they will invariably serve for other uses than fuel. Any that are rotten should be thrown on the fuel stack.

Disposal of stem.—Thus nothing now remains but the stem. I always advocate leaving it in its entirety, and not attempting to cut it up into pieces, which may be suitable for any fixed purpose. The bidders know all its uses well, will turn it to the best account you may be sure, and will bid their best to get it in a fair sale. It should therefore be numbered along with the principal branches and classed under "logs."

Mode of determining weight of timber.—The weight in candies of 784 lbs. of these logs is determined by the following formula :—

$$\left(\frac{c}{4}\right)^2 \times l \times \frac{2}{25}.$$

c is the circumference in feet at the middle of the log, l is the length of the log in feet.

These measurements must be taken most accurately.

Quicker method for determining weight.—The above formula is an extremely tedious means of finding the weight of each log, and I as a rule substitute another, which gives the weight in maunds of 28 lbs., the result can then be easily transformed to candies when necessary, but as a rule 90 per cent. of the logs are less than one candy, hence the saving in calculation. The formula is

$$\frac{c^2 \times l}{7}$$

There is a slight over estimate here if we take the first as absolutely correct, but as this is not the case always, the latter can be used with a certainty of being very near the truth, if fractions of less than half a maund are discarded.

It may appear strange that timber is not calculated by cubic measure but by weight, such, however, is the local system, and must be adhered to for purposes of comparison in prices.

Maximum price of one cubic foot.—It will be seen that 12½ cubic feet are supposed equal to one candy, and the larger the diameter of the tree, the more per candy is given. I have known it go up to Re. 1 per cubic foot, where the piece of wood would be used for an oil mortar, which has a circumference of 10 feet.

Cart shafts.—In the thinnings, a great number of young trees 6 to 8 inches diameter at base suitable as cart shafts are cut out; these should not be cut up like the branch wood, but left in lengths of 15 feet and stacked separately, but in the same manner as the branch wood is for fuel, for by the weight the value is estimated.

Grazing.—Now one word as to grazing in these reserves. If I had merely to state whether grazing should be allowed or not, I should distinctly say no! but as grazing is an evil which has to be permitted, I have only to point out where it can be so with the least detriment to the reserve.

Prohibited animals.—Sheep and goats it is needless to say, should never be allowed within the reserve at any time. I need not give here the endless reasons for this. To sheep and goats, elephants, camels, mules and asses should be added.

Permissable animals.—Cattle of the bovine species common to every village, do the least harm, but they should not be permitted into a reserve, until the bark of the babul, ním, sandal, &c., has hardened. I should fix this on the safe side at 10 years of age, and allow it until the time of regeneration, say 40 years of age. The cattle can then graze for 5 months of the year without doing very much damage. Damage they will always cause; such as deteriorating the growth by what

I call hammering the upper soil into a cake. Again, there are always to be found numerous plots, even in the most regular growths, far in arrear of the rest, and as they are too scattered to permit of fencing, damage is inevitable.

Means of minimising damage from grazing.—But as I remarked above, *if the grazing be sold, say for 5 months, it* will be generally found that the damage is minimised. The cattle prefer the grass as long as it lasts, and it is generally all eaten up by November, and will not grow again until the next year. I think July to December the best months to give. This is a general rule, but I have found it advisable to let the grazing over a later period, sometimes from October to February or even later, when the ground was too moist to allow of cattle entering. In these reserves of course the grass grows as a rule even up to January owing to the moisture.

Sale of babul pods, its consequences.—Babul pods should never on any account be sold to shepherds, even when the trees are very large. The damage that the shepherds do to the trees with their long bamboo poles is enormous. I have seen them breaking even large branches in this operation, and the sheep which are supposed to be in the reserve for the purpose of eating babul pods, devour everything they come across. Even the grass is literally pulled up out of the ground, and next year's crop for the big cattle thereby very much depreciated. In Sholapur the Gowlies positively refuse to buy grass that has been open to sheep grazing, they know it is worthless. Preserve the grass for the Gowlies and five times the revenue will be made that would be if given to sheep.* Babul pods will probably at no very distant date form a large source of revenue from their sale for tanning purposes. I have been in communication with a firm in Bombay this year, 1884, who are making experiments, and I offered to let them have ten tons at any railway station on the Dhond and Manmad Railway if they fixed a fair price, but the offer was declined, at they do not seem to know whether it can be used or not.

Since writing the above, I have noted that, given a field of good black soil, entirely free of lignified vegetation on which it is desired to make a babul plantation, that very good results can be obtained by penning sheep on it during the night in the months of April and May, if it is known that they are being fed on babul seeds. The following monsoon a thick carpet of seedlings will be found. Once these seedlings have sprung no sheep or goats must ever be allowed near the place again. This system is remarkably cheap, but owing to the reserves being as a rule extended in area and generally partly covered with growth, it is extremely dangerous and open to very great abuse when put in practice.

R. F.

* I have proved this clearly in my report on the grazing of the Sholapur Districts of 1880-81.

PROGRESS OF FORESTRY IN INDIA.

(*Continued from page 410*).

THE total area planted with trees of all kinds in the provinces immediately under the Government of India aggregated 33,000 acres on the 31st March, 1882. In the Presidencies of Madras and Bombay also large areas have been planted, and cultural operations of all kinds progress vigorously wherever forest management has been started in India. In addition to the regular plantations there has been much sowing and planting in the forests in order to aid natural reproduction; the areas thus operated upon, however, are not included in the figures here recorded. Broad-cast sowing of seed, without any previous preparation of the ground, has not hitherto yielded good results. Attempts have also been made to favour the growth of the more valuable, by cutting back saplings of the less valuable kinds. The cutting of climbers is an operation peculiar to India. Many forests, when first taken in hand, are found to be full of these large climbing shrubs, the stems of which, as thick as a man's thigh, but as flexible as a rope, were seen winding round the trees or hanging upon them, while the dense foliage of the climber completely smothered the crown of the tree. Teak and sal are frequently attacked in this manner, and the result is stunted growth and irregularly shaped stems. The eradication of these creepers has generally been one of the first operations when the protection of a forest was taken in hand, and in many of the more valuable forests they have been eradicated. When a systematic treatment of the Indian forests was first attempted, it was found that in most cases those forests which were accessible were exhausted, and that only those which were remote and difficult of access contained timber and other material fit for sale. The necessity of making these forests available by improving the export lines and other means of communication forced itself early upon the attention of those who were charged with their administration. In Burma, where the teak timber is floated down from the forests, large areas had fortunately been protected by natural obstructions in the streams, which prevented the export of the timber growing above them. In 1858 operations were commenced to open out these obstructions by blasting the rocks in the rivers, and ever since that time this work has been steadily continued.

In Oudh, Captain E. Wood, the Conservator of Forests, commenced early to divide the forests in his charge into blocks, and so to arrange the lines which separate these blocks that they might be used for the export of timber. The value of the Oudh forests has been greatly enhanced by the complete system of roads (about 900 miles in length) which have thus been made.

Large forests cannot be managed without a well considered methodical plan of working, and the first step in this direction

is the preparation of good topographical maps. At the outset it was necessary to be satisfied with maps of a very rough kind —mere sketch maps. As operations progressed and more accurate maps were required, it was possible in some cases to use the work of the great Indian Survey, but frequently special maps were needed; hence in 1872 it was found convenient to organise a special staff for the survey of forests, and this was done by Major F. Bailey, of the Royal Engineers. This staff, though employed exclusively for forest work, is under the supervision of the Surveyor-General of India.

The necessity for regulating the working of the forests by a carefully devised plan of operations was felt long before accurate maps were available. The first working plans were necessarily of a rough and preliminary kind, and intended to provide for a short series of years only. Thus the Burma Forest Report for 1862-63 contains the outlines of a plan for working the teak forests in that province during a period of twelve years. This plan was revised in 1868, and again in 1880. For one of the finest sal forests in the Eastern Duars—the Buxa forest—Dr. Schlich, while Conservator of Forests in Bengal, proposed (in 1873) a plan, laying down the work to be done during a period of eight years. In the same manner, the working of forests in other provinces was regulated by preliminary working plans drawn up for short periods. The necessity of employing a special agency for this purpose has now been recognised, and for the provinces under the Government of India the control of this most important branch of work has been entrusted to the Inspector-General of Forests.

It will now be well to give a brief account of the staff of officers employed for forest administration in India. In 1864 the writer of the present paper, who since 1856 had been Conservator of Forests in Pegu, and later in the whole of British Burma, was appointed Inspector-General of Forests, in order to advise the Government of India and the Local Governments in regard to the organisation and management of forest business. This appointment is now held by Dr. Wm. Schlich, who joined the Indian Forest Service in December 1866. The chief forest officer of one forest circle is styled Conservator of Forests. In several provinces there is only one circle and one Conservator. On the 1st January, 1884, there were fifteen Conservators, viz.:—

In the Presidency of		Madras, ...	2	Conservators.
„	„	Bombay, ...	3	„
„	Province of	Bengal, ...	1	„
„	„	North-West and Oudh,	3	„
„	„	Punjab, ...	1	„
„		Central Provinces,	1	„
„	„	British Burma, ...	2	„
„	„	Assam, ...	1	„
„	„	Berar, ...	1	„

Each forest circle is divided into a number of divisions, each division forming the charge of a superior officer, who is styled Deputy or Assistant Conservator. Divisions are subdivided into ranges or executive forest charges. The extent of ranges varies exceedingly, according to the greater or less importance of the forests comprised in them, and according to other circumstances. Eventually an area of 20,000 acres, or 30 square miles, will probably be found to be as much as can well be managed by one Executive officer or Forest Ranger, though in special cases, such as large plantations or other forests intensively worked, a Ranger can only manage a much smaller area. It has been stated that the area of Reserved Forests on 31st March, 1882, amounted to 30,000 square miles; hence, if the organisation were complete, the executive management of this area would require a staff of 1,000 Forest Rangers or wood managers. Ranges are subdivided into beats in charge of Forest Guards, whose duty is confined to the protection of the forest.

The Indian Forest Service is thus divided into these main branches—the Controlling or Administrative Staff (Conservators, Deputy and Assistant Conservators) in charge of forest circles and divisions; the Executive Staff (Forest Rangers) in charge of ranges, and the Protective Staff (Forest Guards) in charge of beats.

Only the Controlling or Administrative Staff is recruited from Great Britain, while the officers of the Executive and Protective Staff are all natives of India. The number of Conservators, Deputy and Assistant Conservators, in all parts of British India does not exceed 150, and it is not likely that this number will be much increased in future. Of these appointments, some will always be filled by the promotion of Forest Rangers, natives of India, who have distinguished themselves as Executive officers, so that the number of candidates required annually from Great Britain to fill vacancies is limited. Since 1867 great attention has been paid to the selection and professional education of the candidates destined to fill appointments in the Controlling Staff. It has been recognised that the candidates selected must possess a thorough knowledge of pure and applied mathematics (up to and including plane trigonometry and the binomial theorem), and of selected branches of natural science; and that before going out to India they must make themselves familiar with the administration of large forest domains in those countries where extensive areas of State and Communal Forests are managed according to a regular system.

The formation of the Government forest domains in India, and the organisation of their management, has been a large undertaking, and the progress which has been made in this work could not have been accomplished had the experience gained in forest administration in Europe not been utilised; and in future it will be necessary to maintain an intimate connection between forest

administration in India and in those countries of Europe where scientific forestry is based upon the experience of centuries. Climate and the species of trees are different in India, but the principles upon which systematic forestry is based, are the same in all countries, and the aim in future must be, as it has been in the past, to build the system of forestry in India, not upon the ideas and theories of individual men, but upon the results which long experience has furnished in those countries of Europe where scientific forestry is oldest and best understood.

So far regarding the officers of the superior staff, upon whom mainly rests the responsibility of building up forest administration in India. In the case of officers of the Protective Staff, or Forest Guards, what is necessary in order to ensure efficiency are local knowledge, a strong constitution, active habits, honesty, and general intelligence. Higher qualifications are required from Forest Rangers, and for the purpose of training candidates for the large and important staff of Forest Rangers, a Forest School has been established at Dehra Dún, in Northern India, to which four forest divisions, situated in the plains and in the hills of the Himalaya, have been attached. The arrangement is that eight months in the year are devoted to practical work in the School forests, while the remaining four months, during the slack season in summer, are devoted to theoretical instruction in mathematics, the natural sciences and forestry. All candidates are taught surveying in the field and in the office, and Major Bailey, who organised the Forest Survey, has been appointed Director of the Forest School. As the students at the Forest School come from Burma, Assam, Madras, Oudh, the Punjab, and from other provinces, where they all speak different languages, it is necessary to give the instruction in English; and it has been settled that no candidate shall be sent up from the different provinces who has not received a good general education. Recently a lower class has been established for those who do not aspire to the Forest Ranger's certificate* ; these men are taught in the Hindustani language, and they study for the certificate of Forester, a class intermediate between Forest Rangers and Forest Guards.

At an early date the necessity of providing handbooks for Indian Forest Officers was felt. In 1856 Dr. Gibson brought out a handbook to the forests of the Bombay Presidency. In 1861 Dr. Cleghorn published his well-known work on the "Forests and Gardens of South India." His successor in Madras, Colonel Beddome, commenced in 1869, and completed in 1873, his "Flora Sylvatica of the Madras Presidency." In 1874 appeared the "Forest Flora of North-West and Central India," which had been commenced by the late Dr. J. Lindsay

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* This is a mistake, as the men who obtain the Forester's certificate are eligible for Rangerships 12 months after leaving the Forest School.—[ED.]

Stewart, Conservator of Forests in the Punjab, and which was completed by Dr. Brandis. In 1877 was published the Forest Department Code, which was intended to regulate the conduct of business and the rendering of accounts. In the same year appeared the "Forest Flora of British Burma," by the late Sulpiz Kurz, Curator of the Herbarium at the Calcutta Botanic Garden. A general Manual of Indian Timbers was brought out in 1881 by Mr. J. S. Gamble, the Conservator of Forests in Bengal, and now Conservator in the Northern circle of the Madras Presidency; and in 1882 two most important Manuals for Forest Officers were published by Mr. Baden-Powell of the Bengal Civil Service, who for many years had been Conservator of Forests in the Punjab, and who in 1873 and 1874 had been acting as Inspector-General of Forests to the Government of India. The first of these works treats of the Land Revenue Systems and Land Tenures of British India; and the second is a Manual of Jurisprudence for Forest Officers—viz., a treatise on the forest law and those branches of the general civil and criminal law which are connected with forest administration.

A sketch of the management of the Crown forests in England, of the woodlands or private estates in Scotland, and of forest management in Germany, Austria, and France, is contained in two useful small volumes (published in 1873), and written chiefly by Major Campbell-Walker, now the Conservator of Forests in the Southern Circle of the Madras Presidency, with contributions by Mr. Gustav Mann and by Major Pearson. An excellent little book on Sylviculture by one of the Professors at the French Forest School—the late M. Bagneris—was published in 1882 by Messrs. E. E. Fernandez and A. Smythies, both attached to the Dehra Dún Forest School. A handbook on the organisation and valuation of forests on the Continental system was published in 1883 by Mr. J. L. L. Macgregor, an officer in the Bombay Forest Service. Besides these handbooks and manuals, numerous reports and other official documents on the subject of Indian forests have appeared.

In July 1875 Mr. Baden-Powell and Dr. Schlich issued the first number of *The Indian Forester*, which was commenced as a quarterly magazine, and is now a monthly periodical on Indian forestry. This journal, which was edited by Dr. Schlich until 1878, and by Mr. Gamble until 1882, is now in the hands of Mr. W. R. Fisher, the Deputy-Director of the Forest School, and officiating Director during Major Bailey's absence in Europe.

The object of *The Forester* was to supply a medium for the inter-communication of ideas, and the record of observations and experiments; and not only has this object been accomplished, but those who have contributed to its pages have given material help towards building up a system of scientific forestry in India. One of the great wants felt at the outset was a suit-

table terminology, or a collection of technical terms required for this branch of applied science so recently introduced in India. A series of articles appeared in the magazine written by several of the most competent Indian foresters, in which the English equivalents for the technical terms which have been long in use in forestry on the Continent of Europe, were discussed, and many technical terms are now well established.

Indian Forest Officers have at different times been employed to assist in organising forest administration in various British colonies and dependencies, and the substance of the reports submitted by these officers to the Colonial governments, or other communications sent by them, have from time to time appeared in *The Indian Forester*. Thus in 1876 Major Campbell-Walker was requested to examine the forests of New Zealand, and he submitted proposals for their organisation to both houses of the General Assembly of that Colony in 1877. In 1880 Mr. R. Thompson, Deputy Conservator of Forests in the Central Provinces, was deputed to the island of Mauritius for a similar purpose. The forests of Ceylon were examined and reported upon by Mr. F. d'A. Vincent in 1882. An Indian Forest Officer (Mr. E. Dobbs) was appointed in 1882 to the charge of the forests in Cyprus, and another (Mr. D. E. Hutchins) is at present serving in the Forest Department of the Cape of Good Hope. In this manner *The Indian Forester* has been enabled to give information regarding the progress of forestry, not only in India and Europe, but also in other parts of the globe. The plan of this periodical was first started at a conference of Forest Officers held at Allahabad in January 1874. A second general conference of Forest Officers from all provinces of India was held at Simla in October 1875. The advantages of periodical meetings of foresters charged with the management of extensive estates are well recognised wherever forestry is practised. The results of forest management do not show at once, and the mistakes which may be made in the organisation and treatment of forests do not as a rule manifest themselves until a generation of foresters has passed away, and the work has gone into the hands of new men who had nothing to do with the framing of the original plan. When a bridge is built or a railway is made, it is not generally long before the defects of plan and construction manifest themselves; but the wrong treatment of a forest may not manifest itself for a long series of years. Certain questions, therefore, of forest management should never be left to the judgment of individuals, but should be submitted to the discussion on the spot of a number of competent and experienced foresters.

A free interchange of views on important questions of forest management in India has been attained by periodical meetings of Forest Officers, and it is the recognised practice, as a rule, of the superior officers to consult the local foresters regarding all

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important measures proposed by them, and to discuss with them on the spot in the forests all questions that may arise concerning the management of the estates entrusted to their charge. A useful interchange of views on professional subjects has been started in the pages of *The Indian Forester*, in regard to the "Manual of Indian Sylviculture," a work undertaken by Mr. E. E. Fernandez, and the need of which has been felt ever since the first attempt was made to teach Sylviculture at the Forest School of Dehra Dún. A rough preliminary edition of portions of the work was printed and circulated, and the notes and critical remarks regarding it have been published and discussed in *The Forester*. Useful suggestions regarding Indian Sylviculture are scattered in many official Forest Reports and other publications, but no attempt had been made to treat the whole subject in a systematic manner. The undertaking is large, new, and difficult, and some time must elapse before it can be completed. The study of books may be said to be a necessary evil, in contradistinction to the study of nature in the forest; but whether evil or not, good handbooks are necessary, and it is to be hoped that the "Handbook of Indian Sylviculture," when completed, will be the first of a series of handbooks which will facilitate the study of Indian forestry in all its branches.

These handbooks and periodicals, reviews and reports, however, are only means towards the ultimate object aimed at, and the object is to promote the well-being and to advance the prosperity of the people of India. Well may the question be asked, whether the people of India will really benefit by the establishment and good management of these large State forest domains.

The advantages which the people of India will derive from the maintenance and further development of forest conservancy are of two classes—direct and indirect. The direct advantages are easily defined. They comprise the provision of a permanent and sufficient supply of timber wood, bamboos, and other forest produce for the agricultural population, for towns, railways, shipbuilding, iron smelting, and for export. It might be argued, and it has ere this been argued, that this object might have been accomplished in a different way, and it has been urged that as the demand for timber and other forest produce increases, the requisite supply will at all times come forward without the intervention of Government.

In certain cases and under favourable circumstances private enterprise can doubtless be relied upon to create forests and to supply the demand for forest produce, and there is one instance in India which illustrates this in a remarkable manner. As is well known, the southern part of the Indian Peninsula produces no coal, and there is no prospect of finding it. Hence, the town of Madras, with a population of 400,000 souls, large cotton mills and other factories, Government establishments, and the two railways which have their terminus in that city, are all

dependent for their fuel requirements upon sea-borne coal from Bengal, Great Britain and Australia, and upon wood.

Wood, though it commands a high price at Madras, has hitherto been cheaper than sea-borne coal, and the consumption of it is considerable. It has been variously estimated at from 80,000 to 100,000 tons a year, and the mean retail price during the three years ending with 1880 was about 20*s.* a ton of 2,240 lbs. At this price it pays traders to carry firewood to Madras from distant woodlands, 44 miles by cart, in addition to the same distance by boat—a total distance of 88 miles. But formerly there were woodlands much nearer the town, and the price was less. As these woodlands became exhausted through reckless cutting, and prices rose, experiments were made in the first instance by Government, to plant *Casuarina equisetifolia*, a tree indigenous on the coast of Burma, which was found to thrive well on the belt of sand stretching along the Madras coast. The matter was taken up by landholders and others, and the result is that within the last 20 years upwards of 30,000 acres have been planted by private enterprise to provide for the supply of the town, and that from Madras to Coromandel in the north, a length of 24 miles, and to the Palar river in the south, a length of 40 miles, these private Casuarina plantations form an almost continuous belt of forest about half a mile wide along the coast. It was most fortunate that as the natural woodlands within easy reach of the town had become overworked and ceased to yield, private enterprise stepped in and supplied the deficiency. A regular system of management has developed, and besides yielding fuel for Madras and a handsome income to the proprietors, these plantations have fixed the sand along the coast, and large areas of waste land hitherto almost useless have been utilised.

This is a remarkable and almost unique instance of forests being created and maintained by private enterprise in India. The conditions, however, were exceptionally favourable; the planting costs very little, the operation succeeds with hardly any risk of failure, the crop is fit to be cut after eight years, and the outturn is very large. Under less favourable conditions private enterprise has not come forward to supply the demand for fuel by the railway or for iron smelting, or the demand of other towns. As a matter of fact, had Government not stepped in to arrest the denudation of the country, by protecting the remaining forests and by planting, no action would have been taken in the matter, and the people of India would have suffered. Within the last fifty years the extension of cultivation has been so rapid, that in many districts large tracts have been completely cleared, the forest rooted out, and the land brought under cultivation. Such tracts may be seen in Burma, in the Central Provinces, in South Berar, at the foot of the Himalaya, and in many other parts of India. Hardly in any case has the

foresight of the agricultural population induced them to leave forests standing for the supply of timber fuel, bamboos, and other forest produce. The fertile plains of Tharrawadi in Burma, which were almost continuous forests in 1856, are now open rice fields, with groups of trees and small forests, it is true, scattered among the fields, but they owe their existence to the fact that they chiefly consisted of teak, and that teak was a Royal tree, the cutting of which was prohibited by Government. In other districts, where there was no teak, no trace of the old forest is left—the people suffer great inconvenience, and the formation of village forests is contemplated. In the Central Provinces forests have been preserved by Malguzars or Landholders on their estates, because the timber or bamboos in them were valuable and could be converted into money. In the drier parts of North-West India, where forests are scarce, there has, in some cases, been a tendency towards the preservation of forests, either as sacred groves or for hunting, or in some cases to provide fuel for iron smelting, to protect the water supply in springs and streams, to provide fuel for towns, or to secure a supply of cattle fodder in times of drought and scarcity. But there has been no organised and effective action to accomplish these objects.

As a rule, it may be said, that unless Government had stepped in and had reserved forest tracts, many districts would have become denuded and the people would have suffered. Had the Government not interposed after the annexation of British Burma, the teak forests of that province would have become annihilated, and there would be no prospect of a permanent supply of teak timber from that quarter. The vast and thickly cultivated plains of Northern India depend for their timber, bamboos, and other forest produce entirely upon the forests at the foot of the Himalaya, and had Government not interfered to preserve them, they would have become gradually exhausted.

Cattle fodder has been mentioned among the produce expected to be furnished by the public forest domains in India. Even in this respect Government has had to take the initiative, and action on a large scale is contemplated in the drier districts of Northern and North-Western India. In the small British districts of Ajmere and Merwara in Rajputana, which have a dry and hot climate, with a scanty and uncertain rainfall, the waste land and hills, in that portion which is not included in the large private estates, were originally the property of the State. At the land settlement in 1850, however, the waste land and hills were included in the common land of the villagers, and their management was made over to them, the result being that these lands were gradually denuded. What wood there was, was cut and sold, and the hills became bare. In the drier districts of India grass grows much more plentifully under the partial shelter of trees, though under the cover of dense and closely stocked

forests it is killed out. Hence, in many parts of India the first effect of denudation has been the deterioration of the grazing grounds, and this has been most keenly felt in seasons with insufficient rainfall. The occurrence of such exceptionally dry seasons is unfortunately not uncommon. As the hills and waste lands in Ajmere were denuded, not only wood for the people became scarce, but sufficient pasture for the village cattle was no longer obtainable. Moreover, the water supply in wells and streams became uncertain; many of the tanks constructed by Colonel Dixon, who for many years governed these districts in an admirable manner, were rendered either useless, or their usefulness was greatly impaired, because the smaller tanks silted up from the sand and loose soil washed down from the naked hills, and because in many cases the *bunds* were breached by sudden floods rushing down the bare hill sides. Action became necessary in the interest of the people, and in 1874 a special regulation was passed, enabling Government to take up any tracts of the common lands, for the purpose of forming State forests, certain rights in them being secured to the villagers. Under this regulation upwards of 100 square miles of hills and waste have been taken up in these districts, and they have now been effectually protected for nearly ten years. These operations were undertaken in the first instance with the view of improving the water supply in the wells and tanks, upon which cultivation in these districts chiefly depends, and in course of time their beneficial effect in this respect will doubtless manifest itself; but up to date, the principal advantage has been, that the supply of grass has increased largely. During several seasons of drought which have occurred, the increased supply of grass in the protected areas has been extremely useful. In this manner forest conservancy may be expected to mitigate the disastrous effects of seasons of drought and famine which unfortunately are of frequent occurrence in India. The importation of grain into famine-stricken districts can be facilitated by the construction of roads and railways, but cattle fodder cannot to the same extent be distributed over the country; it must either be produced in the vicinity, or the cattle must be driven away to places where pasture is available. Want of fodder and the consequent mortality among cattle has always been one of the principal evils attending famines in the drier districts of India, and this evil can in many cases be mitigated by forest conservancy. But it is not only the larger supply of grass which is useful in times of drought; the branches of several kinds of trees form an excellent cattle fodder, and during the great famine which devastated Rajputana from 1867 to 1869, the old forest preserves, which the Chiefs of several Native States (notably of Kishengarh near Ajmere) and large landholders had formed, were of extreme value to the people. Special permission was given to lop the branches of trees for the cattle of

the towns and villages in the vicinity, and by these means many were saved from starvation. These preserves in the Native States of Rajputana were of long standing; in most cases they had been formed for hunting and shooting, but in times of drought they proved extremely useful to the people.

(*To be continued.*)

V. NOTES, QUERIES AND EXTRACTS.

DR. GEO. WATT'S MEMORANDUM ON WOODS USED FOR TEA BOXES.*—The memorandum by Dr. Geo. Watt upon woods suitable for tea boxes, which was published on 26th instant for general information, is interesting, in so far as it offers a new and probably an original opinion upon the cause of the damage lately sustained by Indian teas, and which is generally attributed to the action of juices in certain woods coming into contact with the lead lining in which the tea is encased. Dr. Watt suggests that it may be the tea itself which corrodes the metal and not the wood, and the opinion is, as he states, at "variance with the popular outcry." As it differs with a professional opinion which I obtained in London last year, the premises assumed by Dr. Watt being also at variance with the circumstances on which the opinion was formed, I venture to produce this.

Two invoices of 726 cases of tea manufactured during October and November 1882, were shipped direct from the factory, arriving at London *viâ* the Canal in April 1883, and on being sampled were found to have a "peculiar cheesy-like smell." On examination, the surface of the lead next the wood forming the lids to the boxes, was found to be covered with a whitish and, in some cases, a yellowish kind of mould, while the surface against the tea was quite bright and clear; the lead was perforated, and in instances completely corroded. This injury only existed on the tops, the sides and bottoms of the wood and lead casing being unaffected and perfectly sound; and not only so, but in many instances the lead was corroded under only one or two of the several pieces of which the lids were composed, the rest being sound. The wood and lead had a very pronounced and disagreeable smell which had been transmitted to the tea. There was no external sign of damp, and the tea was not damaged in the usual sense of the word; without the smell it would have been in good condition. The tea was turned out on the floor of the warehouse; and pending investigation and examination, it was left exposed for a few days, during which the objectionable smell toned down and left the tea so rapidly that only 64 out of the 726 were eventually condemned as "peculiar,"

* We have not yet seen Dr. Watt's Memorandum, but hope to refer to it in a subsequent number.—[ED.]

and were disposed of as such, although the whole invoice on arrival was tainted. I inspected and sampled the tea in the London warehouse, and extract the above remarks from notes and records I retained.

Samples of the wood, lead, and tea, were submitted to Dr. Augustus Soelcker of London, and the following is his report :—

"Having completed the examination of the specimens of wood and lead from various tea chests which you received from India, I have now the pleasure of reporting to you the results of my investigation.

"The several specimens were marked Nos. 1634, 1731, 1737, 1,742, 1748,—wood from the lids of the tea chests and leads.

"Nos. 2199, 2254, 2304,—wood and lead from the bottom of the chests.

"No. 2038,—wood and lead from a tea chest from another garden apparently sound.

"*The lead taken from the top of the chests was more or less cor*roded in every case, whilst the lead from the bottom of the tea chests was only slightly attacked at the jambs, which may be due to the solder; otherwise the lead from the bottom of the chests was sound apparently, and no perceptible corrosion could be noticed in the case of No. 2038.

"The examination of the corroded leads showed me that the corroded leads are covered in the worst specimen with a white heavy powder which strongly effervesces with acids, and proved to be a mixture of oxide and carbonate of lead, or in the main white lead. Besides this, I found soluble lead salts in the corroded leads. The presence of lead and acetic or analogous volatile organic acid can be readily shown when the corroded leads are washed with distilled water.

"The following tabulated results may give some idea of the relative degree of corrosion to which the leads were subject :—

	Lead in solution *in water.*	Carbonate of lead *insoluble in water.*
	No. 1634.—Strong lead reaction.	Slightly covered with carbonate of lead.
From lead nearest to the lid of the chests.	„ 1731.—Very much corroded, much lead and acid acetic in solution.	Strong effervescence with acid, much white lead present.
	„ 1737.—Very much corroded.	Ditto.
	„ 1742.—Worst damaged lead, not much lead in solution.	Mostly carbonate of lead.
	„ 1748.—Similar in all respects to 1742.	

"No. 2199.—Only slightly corroded on jambs, and showing only slight indications of soluble lead salts.

"No. 2254 and 2304.—The same as No. 2199.

"Lead from a chest from another garden.—No. 2038.—Lead sound.

"The corrosion of the lead unquestionably is due to the attack of acetic and other volatile organic acids which dissolve the surface and sometimes eat holes into the leads, and the subsequent formation of white lead (carbonate of lead) by the carbonic acid of the air.

"Considering the fact that the surfaces of the leads which are in contact with the tea were quite bright and sound, whilst the under surfaces in contact with the wood were all more or less corroded, it appears to me that, in all probability, green or unripe wood has been employed in making the tea chests.

"Such wood is known to generate, in a somewhat warm locality, acetic and analogous organic acids which act upon lead.

"With the exception of the woods from the bottom of chest marked No. 2199 and No. 2038, which are very similar in their character and lighter, and much more porous than the wood from the lids, all the specimens of wood were very similar in appearance. All were tough, hard, and heavy woods: some had a decidedly disagreeable smell; others had only a faint smell.

"On distillation with water I got in some cases most disagreeable smelling products; and by extracting the worst and strongest smelling woods with ether, I obtained oily and resinous matters in appreciable quantities, having an intensely disagreeable smell, reminding one of a mixture of rancid butter and rotten cheese.

"The oily and resinous matter, in short, stank, and had a fishy smell.

"The following tabular statement may not be without interest.

"Wood from a number of tea chests from India :—

Character of the Wood.	*Smell.*	*Distillate.*
No. 1634.—A hard, tough, heavy wood.	Bad.	Smelt very disagreeably.
" 1731.—Similar to 1634.	Very bad.	Strong smell of butryric acid.
" 1737.—Hard wood, like 1634.	Only faint smell.	
" 1748.—Similar to 1737.	Very bad smell.	Smelt very strong.
" 1684.—Apparently bad.	The worst smell.	
" 2199.—Much lighter wood and more porous than the preceding samples.	No smell.	
" 2254.—A dense, heavy wood.	No smell.	
" 2804.—Similar to 2254.	No smell.	
" 2034.—A porous light wood very much like No. 2199.	No smell.	

"It appears thus that some of the woods have a strongly-marked fishy smell, which, no doubt, will be readily communicated to the tea.

"The peculiar odour I found passed off rapidly on exposure to the air, and I would therefore suggest to you to spread out for a short time the tea which, in my judgment, has taken up a more or less peculiar and unpleasant flavour from the wood, and then to re-pack in fresh leads and chests.

"Whilst I have no doubt that the peculiarly nasty smell of some of the specimens of wood which you sent me for examination has been communicated to the tea, I am bound to say that I cannot detect any difference in the two samples of tea which you sent me with the wood from the chest."

It was subsequently ascertained that owing to a large increase to the season's crop, the supply of box lids had run short at the factory, and green wood had to be employed for lids. This was said to be wild mango wood; and unfortunately, in making up the lids, seasoned and unseasoned shooks were used indiscriminately, explaining, perhaps, the appearance of corrosion under only certain sections of the lids.

The above does not go to support Dr. Watt's suggestion that "it is the tea itself which corrodes the metal, and not the wood;" nor do the circumstances support statements in the following paragraphs of the memorandum. Dr. Watt writes:—

(*a*). "That tea may be completely destroyed, and yet upon the most careful scrutiny not a single opening can be detected in the lead, and that it is obvious that, until the lead is corroded through or perforated, any injurious influence which the timber might exert upon the tea could not take place."

The above evidence, and my experience in other instances, so far show that the tea is only tainted when the lead is pierced, and that the strength of the flavour imparted to the tea is in proportion to the degree of corrosion on the lead.

(*b*). "I have not seen a lead lining completely perforated; but it is curious that the fact that the action seems to commence on the inside of the lead, instead of on the outside, or on the surface in contact with the wood (the supposed acid influence which decomposes the metal), has not been apparently observed."

As stated above, the surface of the lead next the tea was bright and clear; the corrosion evidently began on the surface next the wood.

(*c*). "It is some time now since the action of iron nails, screws, &c., was perceived by the planter to be injurious, and in his tables and machinery these are, by the experienced planter, carefully covered over or protected."

It was found that the iron discoloured the golden tips or flower of the leaf, detracting from the appearance and affecting the market value of the tea, but this did not prejudice the liquor or affect the flavour.

If damage arise from the action of tea upon lead, why has it not occurred until now? Why did it not occur when teas were "sun-dried," and, as we know, often imperfectly cured? And why is it not noticeable in teas packed in teak, cedar, and tún woods? On the other hand, it may only now occur in connection with Indian woods, as timber is becoming scarcer and dear, and contractors may have been tempted to deliver inferior and

unseasoned woods. Dr. Watt appears to consider that the system of manufacture may be at fault, adding "the introduction of advanced machinery to lessen the expense of labour would seem to augment the climatic influence upon the manufactured article." But I think it has been proved beyond dispute that with the assistance of machinery, a tea of improved quality and a more marketable commodity is produced. By the use of machinery, fermentation can be arrested in a uniform manner with regularity, and a fresh aroma ("noser") and crisp feel, two qualities having an important market value, are imparted to the tea. If instances do occur showing that some machine-dried teas have reached the market limp and faulty, the workman, and not his tools, will probably be the secret of the defect, or it may be found that the planter labours under the disadvantage of inadequate accommodation or insufficient drying machinery, or both.

Dr. Watt's experiments, with woods and leads, described in paragraph 4, were conducted in Calcutta during the cold weather; and although the timber was damped, it may be supposed that, at this season of the year, it would not resemble the condition of wood at an Assam tea factory during the rains, when after a few days' exposure, the original colour is at times hardly discernible.

I do not in any way pretend, Sir, to solve the question, and merely communicate the above particulars as the result of observation. It is a subject of considerable importance, and the industry is indebted to Dr. Watt for having taken it up.

5, *Lyon's Range;* P. PLAYFAIR,
CALCUTTA, *July 29th, 1884.*

—*Englishman.*

ENSILAGE IN ENGLAND.—A lecture on ensilage as adapted to the English climate and English grasses, was recently delivered before the Farmers' Club, in which the lecturer described the silo as an agricultural jar or jam-pot in which complete consolidation and preservation of the contents may be effected:

Silos above ground appeared to the lecturer to have advantages over those partly above and partly below. As to cost of construction, £1 per ton of silage capacity might be taken as a fair average, where the building was entirely new; and where old barns can be used, either wholly or in part, of course the expense of construction would either be nothing or very considerably reduced. As to the English fodder crops suitable for the process of ensilage, "there can be no doubt," he said, "that ordinary meadow grass is the most universal and the easiest preserved, but clover and artificial grasses present no difficulty. When green rye or oats are intended for the silo, care should be taken to cut them while still sufficiently succulent in the stem, and while the grain is quite milky. This caution is even more necessary in the case of tares which seem generally to have been allow-

ed to get too ripe before being put into the silo." Prickly comfrey, so far as his knowledge extended, appeared to be absolutely unsuitable for ensilage; to preserve cabbage in silos was in our climate a waste of force; and green maize, however excellent as silage, has but a limited interest for the British farmer. But ensilage also enables us profitably to preserve that intractable product, sewage grass, and the coarse and wiry grass that grows under trees and in old nooks and corners.

We see that in the opinion of the lecturer, it is not advisable that the chopped materials should be mixed with salt. The main advantage claimed for the ensilage system appears to be that by means of it, crops can be preserved in wet weather, when it is impossible to make green materials into hay; but we are cautioned against careless treatment, or excessive fermentation which would destroy the nutritive matter. Great stress is laid on the process of ramming down, which should be done thoroughly, and the mass then weighted by some suitable material, such as earth or stone, not loose, but placed in bags or vessels. According to the calculations made, the cost of silage would be about 5*s.* a ton.

With regard to the feeding value of silage, the statements brought forward are of a rather conflicting nature. One speaker puts it down at £2 a ton, and says that it takes five times as much grass to make a ton of hay as is required for a ton of silage, and that therefore a ton of the former ought to have a feeding value of £10 to be equal to silage: another asserts that silage has raised the value of hay; while others again maintain that it has about 30 per cent. more value than hay. Then, with regard to its capacity for engendering milk, the evidence differed very materially. In some cases ensilage was stated to induce a greater quantity and better quality of milk, while in others it was said to tend to an entirely different result. It appeared on the whole that the value of silage as a milk-producer was far greater when employed with other bulky fodders and a certain proportion of cake or meal or both. As regards the powers of silage on the breeding capacity of animals we read:

Experience seemed to show that a judicious use of silage does not interfere with the breeding powers, though in the present state of our knowledge it would be prudent to use silage as food for breeding stock with caution, and to mix it at least with an equal quantity of unfermented, bulky food, such as hay, chopped straw, &c. In his closing remarks the lecturer quoted from his report to the Royal Agricultural Society to the effect that, whatever loss of nutritive matter might result from the processes of fermentation in the silo, the practical value of the process is so great as quite to overbalance this. The system, in the words of a correspondent, is "not an easy and universal mode of salvation to the farmer, but it is a very good system; it demands common sense, care, and attention, but it saves in money, time, and anxiety."

In the discussion that followed the lecture, Dr. Voelcker observed that the nutritive power of silage depends very much upon the quality of the materials put into the silo. Good stuff would no doubt make good silage. Materials immature and low in nutritive value, in spite of being treated thoroughly well, could not be converted into profitable stuff. That was his view of the matter, and it was certainly a common-sense view to take. If, he added, you allow your material to over-mature, becoming thereby woody and stringy, it keeps well enough, for the very good reason that all the component parts of it liable to change have departed therefrom. Then again the doctor had his own views as regards ventilation. It would not do to keep your silage in closed bottles. There are albuminous compounds, he said, which act as ferments just as ferments produce yeast:

These act on the sugary portions. Of course, if you have no sugar in it you cannot produce anything out of it, and the chance is you get dry-rot as in wet woody fibre of any description; but when you have a sufficient amount of sugar, and take care in the making of the silage to press it as you go along, you will get a good result. I would never put more than about three inches without pressing it. If you wait until the layer is two or three feet deep, you may press as long as you like, but you will never turn out first-rate stuff. Then the question is as to whether it wants cutting or not. I believe the ordinary hay, fairly soft grass, or fairly pliable green produce, does not need cutting. Put your grass in whole, but take care to press it down, and never let it lie about for any length of time. Put it in fresh, taking care to ram it down perfectly firm, and build it up in this way. Under these circumstances you will readily understand that, with the exception perhaps of a few inches at the top, the whole mass is solid, and does not admit air freely. What takes place in this case? Supposing you have really good stuff to begin with, it simply breaks up, and the atoms of sugar, carbon, hydrogen, oxygen, arrange themselves in a different manner so as to become lactic acid.

As to this acid, we are told that its constituents are precisely the same as those of sugar, but existing under different circumstances; and the skill of the farmer should be exercised in so excluding the air that no active fermentation can take place, and therefore no appreciable loss of grasses, certainly not to any large extent. Should however the air be admitted, then it rapidly turns the sugar into alcohol, and with an abundant supply of atmospheric air, acetic acid is the result, in which case no doubt loss takes place. The doctor did not favour the idea of utilizing sewage grass or prickly comfrey as silage, as both these, containing a large percentage of water, would not keep for any time:

In conclusion, he said that were he asked what was his opinion about ensilage, he should answer that at present he had no decided opinion one way or the other. He had no doubt that in localities where roots cannot be grown to advantage, ensilage will be of the very greatest benefit to the feeder of stock, and his impression was that it

will come more and more into use, not as a substitute for hay and roots, but as an addition to these.

And the same may be said in regard to India. Where a plentiful crop of grasses or succulent fodder is produced at a season when it is not possible to convert it into hay, by all means try the ensilage system. One of the speakers referred to above was in favor of silos constructed above ground, but stated no reason in support of his opinion besides that of economy. The question, however, was not fully discussed, and we are far from believing that it has been finally settled. We should have thought a silo partly below and partly above the ground would be about the best plan, all things considered.—*Indian Agriculturist.*

INDIAN BUDGET FOR 1884-85.—In commenting on the details of the accounts of the Indian Budget for 1884-85, the Under-Secretary of State thus referred to the Forest Department :—

The Forest Department is gradually becoming more important, and on its good management the welfare of many districts in India very much depends. Both the revenue and the expenditure show a gradual increase. Twenty years ago the receipts were £360,000. They are now just over £1,000,000. In the three years under review they are—

in 1882-83, ...	.. £938,000
in 1883-84, ...	.. £1,011,000
in 1884-85 they are estimated at ..	.. £1,053,000

Whilst the expenses for the same periods are, respectively, £567,000, £686,000, and an estimated £727,000 ; leaving a net revenue of £371,000 in 1882-83, and of £325,000 in each of the succeeding years. To give some idea of the extent of the work of the Department, I may state that the total area of Government forests in British India was in 1882, 72,000 square miles, or more than 46,000,000 acres ; of which about 30,000,000 acres were Government reserve. The future value of this great property greatly depends upon the ability of the young men now training for its management : and it is really of the greatest importance that attention should be paid to the matter ; and so important is it considered, that special instructions will in future be given to a limited number of students at Cooper's Hill College by one of our most able Indian Forest Officers. Some parts of India have been completely denuded of forest growth, with the effect of rendering barren considerable tracts of country. It will be the duty of the Forest Department to give new life to these districts ; and I am told that in some parts of India it is by no means so difficult to do this as might be imagined. But the time at my disposal is not enough for me to give at all a full account of the work of forestry which is going on in India.

I have been asked questions in the House, which indicate an opinion that our Indian Forest Department is not an unmixed good: and there is no doubt that in some instances, common rights, or, I should rather say, customary rights, have to be curtailed. But restriction is necessary in the public interest, because the exercise of these rights, without any regulation, simply leads to certain destruction of the forests, and has a very serious effect upon the rainfall. What is aimed at in the Indian Forest Acts is to forbid altogether the exercise of those practices which are incompatible with the existence of the forests, and to interfere as little as possible with existing customary right. Thus, in every locality some of the forest land is still left open to grazing and firewood cutting; and some is strictly closed for a period long enough to allow the trees to recover.

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DIETRICH BRANDIS.

His Work in the Punjab.

If Mr. Brandis' connection with the Punjab was less close than with some of the other Provinces, it was because the circumstances of that frontier province were widely different, and did not necessitate the same kind of action.

The whole of the forests in the Punjab may be divided into three groups—(1), the waste areas in the plains; (2), the Chil and mixed forest of the lower hills; (3), the deodar and other alpine forests of the Himalaya.

(1). The first group represented the surplus areas of uncultivated land that lay between the different cultivated villages, which in many districts represented as it were *oases* in a desert of scrub jungle and grazing land. In the North-Western Provinces, speaking generally, the districts were more thickly populated, and the areas of waste less extensive. At Settlement therefore all were included in the boundaries of the 'mauzahs' or villages, and such lands as were uncultivated, remained the "shâmilât" or common property of the village. The Punjab was settled on the North-Western Provinces model, but it was soon discovered that the waste areas were too large to be included and given up to the villages. A rule was adopted, of allowing to each village an area of waste equal to from 200 to 300 per cent. on their total occupied area, for future extension of cultivation and for grazing purposes: the surplus was then marked off as Government "rakh." Some of these scrub forests are or were well wooded with jand (*Prosopis spicigera*) and tamarisk in the central and southern districts, and with kikar (*Acacia arabica*) and phuláhi (*Acacia modesta*) further towards the north. Their only purpose has hitherto been to supply grazing to the village herds during the rainy season, and fuel to the towns, cantonments and railway lines, when sufficiently near. At first starting hardly any forest organization was needed. There were necessarily no rights (except in

individual cases of specific grant) in such areas: the grazing was sold by contract, or managed on what is called the "tirni" system. Under this system the neighbouring villages are assessed at so much per head of cattle they possess; this assessment they pay, whether they actually graze or not, but are then free to all the jungles in the circle throughout the year. The collection of fuel was managed by simple means; and as the contractors always cut out the "jand" down to below the root stock, a method which happens to be particularly favorable to coppicing, there was little need felt for anything else beyond a system of securing a certain payment for the area cleared.

The rakhs are now, after an interval of more than 30 years, attracting renewed attention, because (as was inevitable under such conditions as those described) cultivation, surreptitious, or permitted under temporary leases which have in practice grown permanent, has everywhere given rise to claims, and the grazing difficulty has now become pressing, while the increasing scarcity of fuel within reasonable distance, has put a stop to the easy work of the old contractors. The forest authorities have now been long engaging in experiments to see what can be done to increase the growth on areas, where the rainfall is mostly below 15 or 20 inches, and where artificial irrigation is more or less completely out of the question. It has also to be studied whether the "rakhs" are most useful for grazing or for fuel, and whether both objects can be (partially) attained at once.

There was, however, one work to be carried out in the plains, which at any time was obviously desirable. We allude to the work of planting; (1), on such rakhs as skirted the rivers, and (2), on such as were accessible to canal irrigation. Both these works engaged Mr. Brandis' interested attention. Large plantations were formed along the Rávi, and to this day are most valuable in supplying the city of Lahore, the different mills and the engines of the Municipal water-works.

The great plantation of Changa Manga, some 40 miles to the *south of Lahore, at the tail of the Bari Doab Canal, is familiar* to our readers. This was experimentally commenced by Dr. Stewart in the earliest years (1865-66) of the Punjab Conservatorship. Several other areas of a more or less experimental character were also taken in hand. It would have been of little use at first, with our insufficient staff, with men wholly without professional training, who had to learn everything in the hard school of experimental trial, with many drawbacks, and a total absence of any previously recorded work to guide them—it would have been of little use to have commenced with detailed reports and elaborate theoretical schemes. Matters were wisely left alone, to continue in the practical-experimental stage for a few years: but about 1870, things were sufficiently advanced to make it advisable to place a trained officer (Mr. B. Ribbentrop)

in charge of the plantations. In 1872 Mr. Brandis published his first note on the plantation work in the Punjab plains. The suggestions made were simple, cautious and practical. They struck the key note of gradual and steady progress which has ever since been maintained. In plantations in such a soil and climate as that of the Punjab, there is always danger of waste. People indite flaming prospects of what might be done if 'thousands of acres' now lying waste were planted, and wild proposals go forth for "broadcast" sowings. The result is, if too great haste is made, that universal failure provokes a reactionary policy; at any rate much useless expenditure of labor and money is incurred. The problems of plains planting are not yet solved completely, and even where with canal irrigation, 'sissu' has been successfully grown in the deep alluvial but dry loam of the "bar," * it is quite uncertain whether the tree will live long enough to attain real timber dimensions.

(2). The lower hill forests have always presented the greatest difficulty, and again afford little scope for organizing a scheme of demarcation or of working.

The whole system of Government in the Punjab was from the first eminently 'paternal.' In other words, very large powers were left to the district officer to be exercised under very close and personal supervision of the Commissioners and the still higher authorities. It was at first supposed that all these lower hill forests could be quite efficiently protected by the paternal authority of the district officer. Long before any Forest Act had been thought of for India generally, the "Rules for the Conservancy of Hill Forests" (1855) had been introduced in the Punjab. It is true that these contemplate that more defined and detailed rules should be passed under them for each district, but the scope of the rules themselves has been strangely misunderstood, and the greatest nonsense is now being talked about their confiscatory character, &c. But all this is in entire forgetfulness of the circumstances under which they were passed. In form and phrase, they appear to submit everything to the will of the local authorities, and to pay no regard to local rights should such stand in the way. They enable the district authorities to prevent and punish wanton mischief, to enclose patches of young growth, &c., in despite of all rights to the contrary. But all this, in reality, meant nothing more than that the district officer took the jungles under his care, and that he intended to keep them from harm, and that none of his subject-children was to set up any "right" to interfere with this benevolent

* It is hardly necessary perhaps, to explain that, the country rises in level between each of the Punjab rivers, falling again towards the margin of the streams on either side. The high land in the centre is called "bár." Nearest the rivers cultivation is most frequent, because there wells can be sunk with moderate labor; the nearer we approach the "bár," the more abundant the waste and jungle, but also the more difficult are the conditions of growth and reproduction.

action. But it never entered the district officer's head, or that of the framers of the rules, to stop grazing wholesale, or put large areas in a state of high forest culture to the extinction of all rights of user.

Unfortunately, as district work increased, the Deputy Commissioner (who besides might want a special taste or faculty in the matter) became unable to look after the forest in this paternal fashion. Everything gradually slipped into the hands of the local Tehsildar, and then insiduously, patches of cultivation crept into the forest area, till at last what was once a good forest became "honey-combed" throughout. But in the principal centres of these hill forests—Hushyarpur, Kangra and Gurdaspur—the mischevious effects of Mr. Barnes' settlement introduced the gravest complications. Here, the whole of the forest was given up to the villages, to be included in their boundaries, and theoretically and legally at any rate, to become their "property," as in the North-West Province system of village-settlements. No doubt Mr. Barnes himself never contemplated the result that the villagers would be considered "owners" of the forest in such a sense that Government was no longer free to demarcate, to regulate destructive or excessive rights, and to undertake cultural-management. He thought no doubt, that the paternal authority of the district officer would remain unimpaired, and that he might plant, enclose and protect for the benefit of the estate, whether or not it was theoretically included within the village borders.

Unfortunately, but inevitably, in the course of events, different views prevailed ; to this day, the problem of dealing with the Kangra forests has been unsolved, while the Shahpurkandi forests have been abandoned to destruction. Such forests did not offer much scope for administrative action such as the Inspector General to the Government of India was empowered to take, or was able to recommend with any prospect of success. Nevertheless as early as 1868 Mr. Brandis visited these forests, and drew up an instructive journal of his visit ; and he never ceased to afford his countenance and assistance when later, a portion of the forest in Hushyarpur and Kangra was to some extent secured to forest-conservancy.

(3). The forests of the higher hills—

It is an important feature of these forests that they all occupy the upper valleys of the great rivers, and the valleys of the hill tributaries and feeders of those rivers. With the sole exception of the forests of the Beas (Kulu and Seoraj) and some in the remote frontier valleys of Kághán and the Siran, none of these forests are in British territory.

The most extensive of all—in the Jhelum basin—are in Kashmir, and therefore beyond the reach of any interference save that of friendly advice, which has been freely given, but is, of course, never acted on. But the forests in the Ravi, Chenab and Sutlej

are in Protected States, dependent on the Punjab, and therefore some control was always possible; while the facilities were considerable for negotiating long leases of the forests with the Native Rulers.

All the hill forests were liable to the same scourge. The demand for building timber in the newly acquired province of the Punjab was every day growing, and a great impetus was given to the trade, as the produce of all the forests, foreign as well as Native, was floated down the rivers and sold at timber depôts in British territory. On these rivers Government established timber agencies, and did something to control the logs in transit. But nothing was done for the forests themselves. The contractors would send up unscrupulous agents to the hills, where they were often carried about in "kiltas."* They obtained cutting permits from the Rajah's officials, and of course a judicious bribe would secure their winking at 100 trees being cut for every 10 in the permit. Money was freely spent, and as it was more portable, the agents carried rolls of gold in sheet, slices of which were cut off in payment. Bottles of cheap brandy were also frequently used as bribes. The result may be imagined. The trees easiest to cut in the forests nearest the stream, were felled first, no care for reproduction being so much as thought of. As these forests were often situated on easy slopes, natural slides conveyed the logs to the water's edge without loss; but in the higher and more stony hills the destruction was something frightful. No attempt to make artificial slides had ever been seen; a natural "nalla" or ravine served for a timber shoot; a few rocks were removed with the crowbar, or later on (and more rarely) blasted away with powder, and the logs were pitched down. In many cases not one in ten reached the water safely; many were split and shaken, while some struck on rocks, whence an ominous 'bang' told that the timber was shivered into matches. What did it matter? Only one tree in ten, and perhaps not that, had been paid for at an almost nominal rate, and what *did* get into the water sufficiently paid the speculator.

As the forest was always worked from below, such natural seedlings as sprung up, to be the hope of a future forest, were perpetually endangered by the fall of the trees above, as the felling receded, and the logs were rolled over the ground previously cleared. But this was not the only evil. As no time was ever fixed within which the contractors must log, float and remove their material, the same contractors went up season after season for many years, to look after their timber, every season's excursion being the opportunity for new depredations.

To stem this growing evil, the forests must be leased. Much good service was done by many officers on the Sutlej and else-

* The large conical basket familiar to Himalayan travellers.

where in suppressing these abuses, and closing the contracts, but so little known were the forests, that for several years, the work of Dr. J. L. Stewart, the Conservator, and not infrequently of Mr. Brandis himself, was to explore the vallies in order to discover the remains of the forests, to determine their still remaining capabilities, and the possibility of restoring their condition and of utilizing the more remote groups which luckily had escaped the contractor's axe. The late Dr. Stewart's picturesque reports are still remembered in the Punjab.

The first forests to attract attention were naturally those near Simla, the head-quarters of the Government of India. Many interesting notices from Mr. Brandis' pen are on record regarding the deodar localities close to Simla; but the high local value of the wood, and the unwillingness of Government to put pressure on the local Chiefs who owned the forests, prevented any active steps being taken. In the meantime the last relics of the forests are fast disappearing. Even the beautiful Cheog forest, long preserved in part as a temple forest, has now fallen before the superior divinity of rupees, and the imposing stack of brick and woodwork buildings rising at the west end of Simla, represent a thousand deodar trees, the last, or almost the last, spoils of the Cheog deities.

But the Basáhir State forests were further off; and as early as 1864 a lease for 50 years, renewable at the pleasure of Government, was entered into. These important forests have been a constant source of interest to Mr. Brandis, and represent one of the most characteristic of his works. In 1864-65 he visited the forests, and drew up a careful report. This report contained a working plan for five years. Adapted to the comprehension of untrained officers, the plan is very simple and untechnical, but is none the less based on sound scientific principles. The sequence of events has fully justified the adoption of this plan. On the expiry of the five years a second visit was paid, and a further plan prepared which carried on the work to the year 1880.

Mr. Brandis finally studied these forests in 1881, and a further five years' plan, now in operation, was proposed. Nothing can be more interesting than to follow the wise and cautiously progressive series of plans. As the knowledge and science available in the Department has increased, so have the plans become more complete, and more approaching the exact calculation of European working-plans. They also illustrate another point in which Mr. Brandis' work has been so eminently successful. Most of the forests were taken in hand by Government at a time when they had already suffered severely; and it would at first seem that prudence demanded nothing but restoration and the most careful protection for the forests; which means that the Government must be content to spend much and reap little from these estates, for some years to come. But the strong

temptation to Government is to demand a quick and ample return for their outlay; and in the hands of ignorant officers this not unnatural desire might be interpreted into a demand for revenue returns at any price, thus compromising the future, on the principle—the forest will last my time—*apres moi le deluge!* Nothing is more remarkable than the skilful manner in which Mr. Brandis held the balance between true economy and foresight, and the demand for revenue. He knew that a fair balance sheet, was, in the eyes of Government, almost our only *raison d'être.* While therefore he was careful to limit the fellings and to concert measures of conservation and reproduction, he never ceased to insist on making things pay; and this he did not by overtaxing the yield, but by severe economy, careful attention to details, and by making the most of everything, and skilfully turning to account every humble source of revenue. The result has been that while the State forests of India have everywhere improved, the revenue has developed in a manner which is almost surprising.

The Chumba forests on the Chenáb and Ravi had not come under Mr. Brandis' special notice, but the Conservator was indebted to Mr. Brandis for constant advice. These forests had been leased in 1864, but the terms of the lease were less manageable than those of Basáhir. When, therefore, after the first five or six years had been passed in exploring the localities and winding up the often complicated affairs of the numerous timber contractors on the Chenáb, Ravi, Siúl and other tributaries, it was desired to commence demarcation and conservancy, the Superintendent of Chumba offered active resistance. He was willing to see the forests nominally leased in their entirety and in terms which apparently gave a wide and full control, but he expected to see the lease treated like the high-sounding rules of 1855, everything made possible, but nothing really done to curtail waste; above all he was unwilling to see any areas closed against grazing for that regenerative treatment of which the forests stood in so much need. It was necessary therefore to negotiate a new lease, and when that was at last accomplished, a new examination and demarcation had to be undertaken, on principles which had by this time been well understood from Mr. Brandis' unofficial instructions, so that his personal supervision was less needed.

The hill forests of Rawalpindi and Hazára were similarly negotiated for and partly settled, and Mr. Brandis was content to leave that in local hands. Indeed the deodar forests of Kághán are so inaccessible (officers do not visit them without a military guard) that any scheme of regular periodical working and reproduction would be impossible. Occasional fellings of mature trees on the selection method, and a careful conservative treatment of the areas as a whole, represent all that can be attempted. In Hazára, the question of the location of small military summer

stations scattered all along the range on which the main forests be, was still unsettled, and it would have been a waste of time for Mr. Brandis to have entered into organization schemes, when the actual area and resources at our disposal were likely to be upset and altered at any moment.

The Rawalpindi forests were also the subject of a prolonged official contest, which has only now been brought to a close when the district is again under settlement. Mr. Brandis could do little in this matter beyond giving the benefit of his constant advice and of his official support and countenance, which were throughout of the greatest assistance.

The Kúlú forests being in British territory, offered a more promising and important field for action. They were accordingly carefully inspected in 1879, and a joint report was drawn up. In these forests the rights of Government were somewhat undefined, because at the first land-settlement it was found that in Kúlú proper, some of the deodar localities were close to the villages. Had the forests been in the plains, such areas close to the cultivated tracts would inevitably have been given up to the villages ; but with deodar forests, this was felt to be impossible : the areas were therefore left nominally as Government property, but with the understanding that the villages would be as little interfered with as possible. The local authorities were always extremely jealous of any restrictions on the user of the forest by the villages. The consequence has been that from excessive grazing and removal of pine-needles, reproduction has been suspended altogether, while encroachment by cultivated patches has gone on all round.

Mr. Brandis foresaw the difficulty that would always arise in attempting close conservancy of such forests, and he wisely devoted his efforts to secure the largest forest blocks away from the villages, and to obtain areas which, now covered with scrub jungle (the result of the more ancient method of temporary cultivation resembling the "toungya" of Burma) might, from their suitable slope and situation, be restored by planting to deodar forest. It is very strange that in the long official controversy which has arisen on the Conservator trying to get this plan of demarcation carried out, this essential feature of the proposals has been ignored. Remembering the deodar groups of Kúlú proper, that happened to be close to villages, and that were in fact only sparingly proposed for reservation, the authorities imagined inconvenient results, instead of studying the actual proposals. As it is, the report shows how well Mr. Brandis understood his task : and in fact it only errs in being too moderate. It is always forgotten by the adherents of the anti-forest policy, that the real and lasting welfare and convenience of a mountain population, is *not* studied, by letting every one do as he likes : for if the forest is not cared for—if the cake is not taken away from the crying child, and sparingly

doled out by a careful but unappreciated hand, there will soon be neither wood for building or for fuel: the exhausted forest will disappear, and there will be neither pine-needles for manure, nor grass for the flocks.

The fallacy of which all anti-foresters are enamoured is this—*that conservancy is a luxury only needed to produce the* best and finest timber; and that for ordinary village use, forests left freely open and uncared for, will *go on for ever* supplying what the villagers require. Nothing can be further from the truth.

While thus the different groups of forest in the Province received the attention which was possible and suitable for each, there were many other branches of forest administration to which Mr. Brandis devoted his care and skill. The organization of the establishments, the improvement of the prospects of the staff, the accounts, the long-continued operations for the supply of fuel, and also of sleepers for the Northern State and Indus Valley Railways. All these matters could never have been advanced as they were without Mr. Brandis' advice and support, and both have at all times been cheerfully given.

The hand of a master is seen as much in what he lets alone when it is going well, as in what he himself takes into his own care, and the forest administration of the Punjab during Mr. Brandis' Inspector Generalship was eminently an instance of this.

PROGRESS OF FORESTRY IN INDIA.

(*Concluded from page 462*).

When forest conservancy in India was first talked of, the idea uppermost in the minds of most people was that the production of large timber must be the chief object to be attained. What has been stated will have explained that in India the business of the forester is to produce not only timber, but also *fuel, bamboos, caoutchouc, catechu,* and a great variety of other produce, among which cattle fodder is one of the most prominent. The benefits of forest conservancy in regard to the last-named point have, however, only been fully recognised within the last few years, and large schemes have lately been framed by the Government of India for the establishment of extensive fodder and fuel reserves, similar to those of Ajmere and Merwara, in all the drier districts of Northern India; action in the same direction has also been taken in the Presidencies of Madras and Bombay. The chief objection hitherto raised against these measures has been that the closing of a portion of the grazing lands, which of necessity is the first step, causes inconvenience; but it is recognised that the inconvenience will be temporary, and will produce a future supply of fodder which will be far

larger and far more certain than that of which the owners of cattle have been temporarily deprived.

So far regarding the direct benefits of forest conservancy to the people of India. Regarding the indirect influence of forests much has been written, but very little is as yet known with certainty. It has been maintained by enthusiastic writers that the climate of India could so far be changed by means of forest conservancy that the seasons of drought and scarcity would be less frequent. The climate of the different districts of India is exceedingly varied, and the climate of each district depends upon its geographical position, its elevation, the configuration of the ground, and upon cosmic causes which are independent of local circumstances. It is possible that among the many factors which influence the climate of a district the existence of extensive forest tracts may be one, but we have no reason to believe that the operations of forest conservancy which can be undertaken in India will materially improve the climate, or will guard against the recurrence of seasons of excessive drought. We must be satisfied with knowing that in the vicinity of dense forests the air near the ground is generally moister during the dry season and the dew heavier than in the open country. We also know that a gauge placed above the crowns of the trees in a forest collects more rain than another placed in its vicinity at the same height but outside the forest. Nor is there any doubt that forests, if well stocked, afford effective shelter against scorching winds, and that in the hot weather the shade and shelter afforded by trees is a great boon, and is beneficial alike to man, to crops, and to cattle.

These, however, are advantages which, though exceedingly important, only affect the immediate vicinity of the forest. As regards the effect upon the climate of entire districts, there is a widely spread notion that forests tend to increase the rainfall, and that in a warm climate the denudation of a country diminishes its moisture. Much of what is known regarding the history and the present condition of the countries round the Mediterranean seems to support this theory, which has not, however, been established by conclusive evidence ; and the result is that as yet there are no data to prove any climatic influence of forests except in their immediate vicinity.

Regarding the effect of forests in protecting the soil and regulating the surface and subsoil drainage, more definite data are available. As far as our knowledge goes at present we are justified in believing that the action is this : the foliage breaks the force of the rain, which therefore falls upon the ground more gradually and gently ; the loss by evaporation is less ; decayed leaves, moss, twigs, and other matter on the ground in the forest act as a sponge, and prevent the rapid surface downflow of the water ; the soil, which is permeated by roots and is mixed with vegetable mould, is loose and facilitates the percola-

tion of the water, which comes out at a lower level in the shape of springs; less soil is washed away from the hill sides, and less sand and silt are carried down by the rivers.

The beneficial effect of the action of forest in this respect is chiefly felt when the ground is hilly; and it probably is greatest in a tropical or subtropical climate, where the rain comes down in torrents and evaporation is very rapid. It must not, however, be forgotten that the effect of forest upon subsoil moisture is of a most complicated nature; for while, on the one hand, shade diminishes the evaporation of the rain water, there is no doubt that under certain circumstances trees tend to dry up the soil, the roots drawing moisture from great depths, which is evaporated by the leaves. It is a common practice to dry up small swamps and wet places by planting fast-growing trees, and cases are known in India in which the effect of plantations has been to diminish the water supply in wells in the vicinity. This withdrawal of the subsoil moisture by trees is, however, limited to the land on which the trees grow, and does not affect the action of forests growing on slopes or on hilly ground in increasing the proportion of the water which percolates into the ground and reappears at a lower level. That springs in hilly countries disappear or yield less water after the forest in their vicinity has been cleared is a well-known phenomenon, and many such instances are on record in India; nor is there any doubt that streams which take their rise in dense forests flow more evenly and are less subject to excessive floods than streams which rise in a bare and open country. In 1878, a road was constructed through certain forests in Berar, portions of which had been protected against fire for some time, and had thereby become dense and heavy, while the remainder was in its original state of open scrub with a few trees. During the rains, it was found that while all the streams issuing from the open forests had been in flood, those coming from the protected portion had been flowing gently and evenly, and no damage had been done to the bridges which on that section of the road were under construction.

Open and imperfectly stocked forest, where the grass and leaves are consumed by the annual fires, has no effect, or hardly any, in protecting the soil, in regulating the water supply, and in diminishing floods. Only dense forest which is safe from fire, and the ground under which is covered with the remains of grass, twigs, and leaves, can be expected to have an appreciable effect in this respect.

The influence of forests in diminishing floods in hilly countries is now generally recognised in Europe; and in France, not only foresters, but also engineers, seem now to be unanimous in demanding that the operations for controlling torrents and planting up bare slopes in the Alps, the Pyrenees, and the mountain ranges of Central France, which have been in progress since

1860, must be prosecuted on a much larger scale, chiefly in order to diminish inundation. It does not follow from this that in all cases floods are caused by denudation, nor is it maintained that in India or in any other country floods in rivers caused by the melting of snow or by unusually heavy rain falling over large areas can be prevented by the operations of the forester; it is sufficient to know that forestry can do much to diminish the evil.

In a large portion of India, the crops depend either partially or wholly upon irrigation, and the water is derived from tanks, wells, or rivers. The tanks are water reservoirs of various extent, generally constructed by damming up a stream or river in a convenient place; but there are also smaller storage tanks which are fed only by the surface drainage flowing direct from the catchment area. Tanks of this latter description would store the largest proportion possible of the water coming from the catchment area, if that area were made impermeable to the rain which falls upon it. In such cases trees and forest upon the catchment area are injurious, and several instances have been observed where such tanks have ceased to be filled since the forest on their catchment area has become dense and heavy. It is different with the larger tanks, which are fed by springs and streams; these benefit largely by thick forest growth upon their catchment area. The area irrigated from wells in the different parts of India is very large; thus in the Madras Presidency, two million acres are irrigated from wells, while three million acres are irrigated from rivers and tanks. There is no reason to believe that forest growth on level ground has the effect of raising the subsoil water level, which is tapped by the wells; but wells are frequently dug at the bottom of a valley or near the bed of a stream, and in such places there is ground for believing that the underground water stratum which is tapped by the wells will be supplied more plentifully, and that the supply will be maintained longer during the dry season, if the hills which surround the valley are clothed with dense forest growth. Wells of this description are numerous in Ajmere and Merwara, and one of the objects for forming the forest reserves in those districts was to improve the water supply in these wells.

The Indian rivers which feed the canals used for irrigation are of two classes. The Ganges and Indus and their tributaries are fed by the snow which falls on the Himalaya mountains and by the plentiful summer rains of the monsoon. The water supply of these large rivers cannot materially be affected by the small forest area which it may be possible to place under good management on those mountains. Of the other rivers which are used for irrigation, the most important are the Sone in Bengal and the Godavery, Kistna, and Cauvery in the Madras Presidency, but there is a large number of smaller streams besides. These rivers and their feeders rise in the hills of Southern and

Central India, which derive their water supply chiefly from the summer rains of the south-west monsoon. In regard to these rivers, there is good ground for believing that their water supply is largely affected by the forest growth upon their catchment area, and that in some cases, denudation has already done great damage in this respect.

The Tambraparni, in the Tinnevelly district, is one of the smaller rivers used for irrigation in India. Its catchment area 1,739 square miles, of which 1,389 are in the plains and 350 square miles in the hills on the eastern slopes of the ghâts. This river irrigates the large area of 170,000 acres, or 265 square miles of rice fields, more than one-third of which bears two crops. It is a beautiful sight to see this large expanse of brilliantly green fields at a time when the country around is parched and barren. This river carries down into the plains a very large proportion of the rain which falls upon its catchment area, and there is good ground for believing that if the forests, which fortunately are dense and extensive near its head-waters, were cleared, a larger proportion of the rain water would be lost by evaporation, and that the supply, which now flows almost uniformly during the greater part of the year, would come down in sudden rushes after each heavy fall of rain, and would be more irregular.

In the case of another river, the Bhováni, which rises in the Nilgiri Mountains, the mean annual quantity of rain which falls upon its catchment area has been estimated at 175,000 millions of cubic feet, and of this quantity, 11,000 millions or 44 per cent. of the annual rainfall reach the anicut or dam where the irrigation canals take their rise. In this case, therefore, more than one-half of the rain which falls upon the catchment area is lost, and there is good ground for believing that if the forests were cleared away the loss would be much greater.

It is obviously necessary to establish by unmistakeable evidence the effect which the improvement of forest growth has upon the water supply in wells and rivers, and definite proposals have long ere this been submitted to Government for a series of systematic experiments, to ascertain the extent to which the improvement in forest growth raises the water-level in wells and improves the water supply in rivers. Unless these matters are proved by precise experiment, steady progress in forest conservancy, to the extent demanded by the interests of the country, can hardly be expected. The objection can always be raised, that forest conservancy has been carried too far, and that its indirect advantages are imaginary. It is necessary to place an undertaking so important for the welfare of the country upon a safe footing, beyond the risk of a reaction which might undo all the good that has been accomplished by the labour of years ; but on the other hand, if the beneficial effect of forest conservancy upon irrigation has been established by actual experiment, it

will be possible to find means for extending conservancy even to those forests which cannot be expected to yield any revenue.

When the indirect advantages of forest conservancy are fully proved and recognised, the main difficulty will be to find a market for the wood produced in the forests protected, improved, and formed in the hills from which rivers used for irrigation take their rise. From this point of view it will be understood that it is an advantage to encourage the use of wood as fuel for railways or manufactories, and of charcoal for iron smelting. At first, when railways and other public works were constructed on a large scale in India, the increased consumption by them of timber and fuel may have tended towards the destruction of the forests and the denudation of the country ; but this was merely a transitory phase. Now, since efficient measures have been taken for the formation and improvement of forests in almost all parts of the Empire, the aim must be to find a market for the wood and other forest produce which, in a forcing climate and under good management, will be produced on a very large scale. There will, as a rule, be no difficulty in finding sufficient demand for teak and other really valuable timbers ; but, as already stated, the less valuable kinds profit equally by protection, and special measures will be required to create a demand for them. From this point of view, it will be understood why efforts have lately been made by foresters in India to stimulate, and in some respect to resuscitate and to improve the old native iron industry, which, working with charcoal and with the rich indigenous iron ores, has produced and may still produce iron and steel of excellent quality. If the efforts made in this direction are crowned with success, it will be a benefit to the country in every way. Near the coast, sea-borne coal may eventually displace wood and charcoal for most large industrial undertakings. The coal-fields of Bengal, Central India, the Nizam's territories, and Assam supply coal to a large portion of the inland districts, but there will always remain in India many tracts where wood and charcoal will continue to be used ; and though the charcoal-made steel and iron of India, even if the methods of manufacture are greatly improved, is not likely to be exported, and may not be able to compete with the steel and iron imported from England, still for many purposes the native made iron is to this day preferred by the people ; a large native iron industry is still in existence, and it is not impossible that iron smelting in India by means of charcoal may have a future before it.

Whatever views may be held regarding the effect of forests in regulating the surface drainage and in improving the water supply in springs, rivers, tanks, and wells, there is no doubt that on hills clothed with forest the soil is protected, that less soil is washed away, and that less sand and silt are carried down by the rivers. There is not a district in the moister regions of

India where the effects of denudation in this respect are not visible. The sand which is washed down from the denuded hills in the Hoshiarpur district of the Punjab has destroyed the fertility of large areas, and ravines and torrents are numerous in the more thickly inhabited portions of the Himalaya. Even in the Nilgiris the evil will be felt sooner or later, although these hills are favoured beyond any hill range in India by gentle slopes, deep soil, and a moderate rainfall; every year masses of fine silt, which, if retained, might be a source of wealth to the European planter as well as to the native cultivator, are washed down from them into the rivers. The Ratnagiri district on the western coast, south of Bombay, is almost bare to the crest of the ghâts, and the effect of denudation has shown itself by the silting up of the streams which rise in the ghât mountains, and run a short course to the sea; some of these rivers were formerly important for the trade of the country, but now they are only navigable for small boats. The benefits, direct and indirect, which the people of India will derive from forest conservancy, if continued in a systematic manner, can hardly be overrated.

A commencement has been made, but a great deal more remains to be done, and for a considerable time to come the chief work must be accomplished through the agency of Government. This may be questioned by those who consider that the agency of Government should be restricted to the utmost; but had the Government not taken the initiative, no adequate measures would have been taken, and the consequences would have been serious. In this respect India does not stand alone. In nearly all countries of Europe, in Japan, and in most colonies and dependencies of Great Britain, the forest question has been taken up by Government, and in some countries, as in Germany, France and portions of Italy, a regularly organised State forest administration is several centuries old. In the United States it is beginning to be recognised that the present destruction of forests cannot go on much longer without serious injury to the agricultural and general interests of the country. Not only have private associations been formed, in order to encourage planting and a more careful management of existing forests, but one of the States, Massachusetts, has passed an Act authorising towns and cities to provide for the preservation and reproduction of forests; and in the United States Department of Agriculture a forestry division has been formed, in order to collect and disseminate information regarding planting and the management of forests.

In England there are Crown forests, but they are not very extensive; and though, when oak was first planted in them on a large scale the idea may have been to secure a permanent supply of timber for the navy, that object has long ceased to have any national importance, for abundant supplies of timber are brought from all parts of the world, and oak in ship-building has to a

great extent been displaced by steel and iron. Moreover, the woodlands on private estates in Great Britain are extensive, they yield large supplies of timber and other forest produce, and in the moist and temperate climate of the British islands the indirect advantages of forest conservancy are of less importance than on the continents of Europe and of North America. Yet, if the plan is carried out which has been formed of planting up a portion of the waste lands of Ireland, in order to make them more productive and to regulate the flow of water from the hills, some action by the State will have to be taken.

Although in India the State has taken the initiative, it does not follow that all work of forest conservancy throughout the country must be done by the British Government. At the commencement systematic forestry was like a plant of foreign origin, and the aim must be to naturalise it. In this respect some progress has been made. The Chiefs of several Native States and large landholders have commenced organising the protection and management of their woodlands on the model of the Government forests, and they now send their own men to learn their profession at the Dehra Dún Forest School. Fortunately the climate in many districts is exceedingly favourable for forest growth, and the progress made by plantations and forests which have been effectually protected is exceedingly rapid. Land which twenty years ago was bare, or bore only open scrub and a few isolated trees, is now stocked with dense forest from 20 to 80 feet high. Such results of good management are more effective than any amount of teaching and persuasion, and hence the example set by Government is now followed by others.

A remarkable instance has occurred in France, within the last thirty years, of private forests created on a large scale, the example having been set by the operations of the State in the immediate vicinity. It is well known and need not here be told how the Dunes, a belt of sand-hills which stretches for more than 100 miles along the coast of Gascony, between the Gironde and the Adour, were planted up by Government with "Pin maritime" (*Pinus Pinaster*). This work, which was commenced in 1790, was completed about ten years ago, and the result is the conversion of 155,000 acres of white shifting sand into productive pine forests, which yield resin and timber. The larger portion of the forests thus created was sold between 1861 and 1865 to private proprietors, and this sale realised over 13 millions of francs. Inland of the Dunes stretch the vast plains of the Landes, a district proverbially infertile and unhealthy. A little more than thirty years ago an attempt was made to drain this country and to plant the pine which had succeeded so well on the Dunes; the high price of resin during the American War stimulated these operations, and the greater part of the Landes are now stocked with forests, mostly private, which cover an area of 1,692,000 acres.

The most important product of these pine forests of the Dunes, as well as of the Landes, has hitherto been resin. During the American War, and some time after its conclusion, their management was exceedingly profitable; but since the American resin and turpentine industry has recovered, the Pitch pine (*Pinus australis*) of the two Carolinas, Georgia and Florida, has become a formidable competitor of the "Pin maritime;" the price of resin has consequently gone down, and it may now be necessary to alter the management of these forests, so as to aim at the production of large timber, and to plant the Cork Oak among the pines. It may be doubted whether, in the interest of the country, the sale of so large a portion of the Dune forests in 1861 was a wise measure; for, as a rule, the State is in a better position than private proprietors to make experiments on a large scale, in order to determine what system of forest management is best suited to the circumstances of the case.

This lesson may be learnt, that in matters connected with the management of forests the Government may usefully take the initiative, but its measures must be so framed as to facilitate and not to discourage the action of private proprietors. In France, the amount voted for the current year for the restoration of bare mountain sides under the law of 1882 is £186,000, and very large sums have been spent for the same purpose annually, ever since the first law on the subject was passed in 1860. A large and efficient staff of forest officers has gradually been organised to carry on these operations, and it is confidently expected that eventually the hearty co-operation of village communities and private proprietors will be secured, so that in the end the action so long and persistently taken by Government for the public benefit may result in the better management of all pastures and woodlands in the Alps and in the other large mountain ranges of France.

In India, certainly, it will be impossible for the State to provide means for the protection and improvement of the woodlands to the extent required in order to secure to the country the full benefits expected from forest conservancy; a large share of the work must be undertaken by native princes within their territories, by landholders on their estates, and by village communities on the waste lands in the vicinity of their villages.

Landholders and native princes will be induced to preserve their forests by seeing the results of good management in the Government forests. In regard to village communities, the Government must take the initiative; and as a preparatory measure, provisions regarding village forests have been inserted in the India and Burma Forest Acts. To set forth the further measures which should be taken for the establishment of village forests in India would lead too far. It suffices to say that the object must be to constitute village forests for the benefit of

village communities, or groups of villages, and to arrange for their protection and management by the community under the control of the State. Not only will these forests yield a permanent supply of wood and fodder to the people without any material expense to the State, but, if well managed, they will contribute much towards the healthy development of municipal institutions and of local self-government. In many parts of France, Germany and Italy, the old communal forests are a source of wealth to the country; the income derived from them pays for the construction and maintenance of roads, bridges, churches, school-houses, and other public buildings; and there are many towns and villages where a large portion of the municipal expenditure is covered by the revenue derived from the forests belonging to them. But even in Europe the necessities of the present are stronger than the care for the future, and the communal forests would often be worked in a wasteful manner, if their management were not controlled by the State.

The growth of forestry in India has been silent, and but little is generally known regarding it. Wherever it was possible, the plan adopted has been to concentrate efforts upon limited areas, to undertake one task only at a time, and not to fritter away, by a variety of occupations, the time and strength of the staff available. Enthusiastic foresters may at times have desired a more rapid advance; but the slow and steady progress made, wherever circumstances were favourable, has proved a safeguard against the tide of re-action, which, in India at least, not rarely sets in against projects and measures that have been pushed on too fast. If Indian forestry is permitted to continue its progress without any retrograde movement, it will, from a small beginning, grow into a large institution, which will strengthen the position of Government, and will promote the prosperity of the people.—by D. BRANDIS. *From "Transactions of the Scottish Arboricultural Society," Vol. X., Part iii., 1884.*

FORESTRY IN SOUTHERN INDIA.

By MAJOR-GENERAL MORGAN, *late Depy. Conservator of Forests Madras. Edited by* J. SHORTT, *retired Deputy Surgeon-General, Madras Army.*

ON reading the title we opened this book with great expectations, anticipating to pass a pleasant hour in its perusal, but alas our pleasure was soon damped, and had yielded to a feeling of disappointment long ere the last page was reached. The title is a somewhat ambitious one, but the author modestly says in the Preface that—"I have put together the result of my twenty years' experience in the hope that they may be useful, though imperfect." The punctuation is deplorable throughout, and we should never have imagined the existence of an editor if his name had not been given on the title-page; thus, at page 39 this sentence occurs:—"It will, of course, be advisable to select the most valuable kinds for reproduction, such as certain Terminalias, *viz.*, Glabra, Coriaria, Hardwickia, binata, Soymida's febrifuga, Acacias." From this we should infer that Glabra, Coriaria, Hardwickia and binata were all Terminalias, that Hardwickia and binata were two distinct species, and febrifuga a medicine patented by a man rejoicing in the name of Soymida;

glabra again is spelt with a capital 'G' instead of with a small one.

The book has evidently no pretentions to be scientific, but still it might avoid such a glaring error as the statement that the mahogany is a leguminous tree.

Sometimes it is contradictory. Thus we are told at page 1, and correctly so, that although every teak seed (the fruit is meant) may have four cells, they are not always full, for sometimes one (meaning one seed) germinates, but often two, rarely three, and scarcely ever four, whereas in the Introduction, which strange to say, is devoted wholly and solely to the description of the teak, we are told that the nut is one-seeded. We should not call the teak a very hard wood, and do not know what facts exist which justify the assertion that it is more durable than oak.

The arrangement also is not so good as it might be. In Chapter I. on Teak Forests, we are told about main roads, bridges, elephant's food, elephant's mahouts, nature of elephants, how to treat wounds, &c., whilst under sandal-wood we are told about lime in teak. Chapter XII. is devoted to Fuel Plantations, after which we have two chapters on other subjects, returning again to Fuel Plantations in Chapter XV.

At page 13 it is stated that—"With regard to planting and forestry in India, the European Forester has much to unlearn." If it had been *had much to learn* we should have agreed with the writer.

There is, however, some useful information given, especially in the two prize essays on Fuel Plantations, one by Major General Morgan, and the other by Mr. Rhodes Morgan. In the first we find that *Casuarina muricata* is the only tree to plant in Madras on low ground with a sandy soil, the water-bearing surface being within 6 feet of the surface for the greater part of the year. Its growth is exceedingly fast, and as fuel, its calorific powers are unsurpassed by any ordinary wood. In 40 years the profit per acre is calculated at Rs. 3,298, and if the casuarina be treated partly as a fuel and partly as a timber plantation, the profit per acre in 30 years is shown to be Rs. 7,009.

For the hills between 4,500 and 8,000 feet eucalypts are recommended, the plantations made to be partly for fuel and partly for timber, and in 40 years the balance sheet is estimated to show a profit of over Rs. 10,000 per acre.

It is stated that vermin (rats, &c.) can be kept from young plants by strewing pods of cowhage (*Mucuna pruriens*) round the stems of the seedlings, and judging from our first introduction to the plants in question, we admire the prudence of the rats in avoiding them.

With regard to some of the introduced Australian trees, we are told that *Acacia decurrens* grows from 4,000 to 7,000 feet. *Acacia Melanoxylon* and *dealbata* from 5,000 to 7,000 feet, whilst the *Eucalyptus Globulus* delights in an elevation of 7,000 feet, and

bears 10 degrees of frost, a rainfall of 50 inches a year suiting it well. The mean temperature at Ootacamund is 56°, and in that latitude 12° north the Blue Gum does not succeed below 5,000 feet.

Chapter XIV. gives a long list of Minor Forest Products of Madras. *Cryptostegia grandiflora* is said to yield a splendid quality of Caoutchouc far superior to the Ceara rubber. It is only cultivated in gardens. Cardamoms in Malabar sell when cured at from Rs. 50 to Rs. 110 a *tulâm* = 32 lbs. English. *Cæsalpinia Sappan* is extensively cultivated throughout Malabar, and when a daughter is born in a Thean family, the father plants a certain number of Sappan trees, which form her dowry when married.

NATURAL HISTORY OF THE MAMMALIA OF INDIA AND CEYLON. *By* ROBERT A. STERNDALE, F.R.G.S., F.Z.S., &c.

FIELD-naturalists, sportsmen and others, who take an interest in the wild animals inhabiting our jungles, must all have felt the want of a really good book of reference, by means of which they might easily and quickly determine species unknown to them. Up to the present time our only book on the Mammals has been Jerdon's "Mammals of Continental India." Like his valuable book on the Birds of India, the 'Mammals' shows a terrible want of scientific arrangement, without any keys to the orders, genera and species, which renders it always troublesome and sometimes very difficult to determine a species even when the description is good, which is frequently not the case.

Mr. Sterndale calls his book a "popular" manual. Every body, however, is not familiar with the scientific terms which, in spite of the author's having "discarded the stiff formalities of compiled Natural Histories," could not be eliminated without depriving the descriptions of all real value, and it appears to us that the popularity of the work would be considerably enhanced by the addition of an introduction explaining the technical terms and classification.

As stated in the preface this book is superior to Jerdon's, in that it includes the mammals known to occur not only in Continental India, but also in Burmah, Ceylon and India generally. Altogether, about twice as many species are described as in the older work. It also contains many illustrations which will be an assistance to the student, more particularly to the "popular" reader, whose chief stand-by they will probably be. But many of these wood-cuts are very indifferent productions. Take, for instance, the stag-cheetul—one of the best—at page 507, or the bison, at page 482, a most cadaverous specimen in the last stage of consumption (every sportsman knows that

bison are always in good condition), or the buffalo, at page 490, which is a still more wonderful drawing. Certainly the illustrations do scant justice to the author's well known artistic talent. The book is very well printed, and contrasts most favourably with the 'Mammals' in this respect. In all other respects, *it is much the same as that book, which seems to have been* taken as a model, and which has been largely indented upon for descriptions, as is frankly acknowledged by the author.

We may fairly congratulate Mr. Sterndale on having produced a work well adapted to meet the want which it is intended to supply, and hope before long to welcome a new edition with improved woodcuts and the additions which we have ventured to suggest.

M. G.

V. Notes, Queries and Extracts.

THE ASIATIC ELEPHANT IN FREEDOM AND CAPTIVITY.

BY G. P. SANDERSON, *Superintendent of Government Elephant-catching Operations in Bengal.*

WHILST the popular interest felt in the elephant is, perhaps, greater than that attaching to any other wild animal, I think it may be safely said that regarding none, tame or wild, do more fallacious impressions exist.

The peculiar opportunities which have been afforded me during fifteen out of nearly twenty years spent in India, of observing the elephant in its wild and domesticated states—opportunities which it has been at once my duty as a public servant and my delight as a sportsman, to make the most of—have induced me to believe that what I may be able to tell you to night, regarding some of the most interesting features of the Asiatic elephant, may be acceptable to you, as being facts, and perhaps be of some small service to the cause of natural history. I will first commence with a few remarks on the elephant's intelligence.

The elephant's size and staid appearance, its gentleness, and the ease with which it performs various services with its trunk, have given rise to the exalted idea of its intellect that prevails among those not intimately acquainted with it. And its being but little known in Europe, whilst what is known of it justly makes it a favourite, leads to tales of its intelligence being not only welcomed with pleasure, but accepted without investigation. Many elephant stories are intended for the amusement of little folk; but in a sober inquiry into the mental capacity of the animal, they must not be accepted as facts.

The opinion is generally held by those who have had the best opportunities of observing the elephant, that the popular estimate of its intelligence is a greatly exaggerated one; that, instead of being an exceptionally wise animal, its sagacity is of a very mediocre description. The truth of this opinion no one who has lived amongst elephants can doubt. It is a significant fact that the natives of India never speak of the elephant as a peculiarly intelligent animal, and it does not figure in their ancient literature for its wisdom, as do the fox, the crow, and the monkey.

One of the strongest features in the domesticated elephant's character is its obedience. It may also be readily taught, as it has a large share of the ordinary cultivable intelligence common, in a greater or less degree, to all animals. But its reasoning faculties are undoubtedly far below those of the dog, and possibly of other animals; and in matters beyond the range of its daily experience it evinces no special discernment. Whilst fairly quick at comprehending anything sought to be taught to it, the elephant is decidedly wanting in originality. To begin with, the elephant displays less intelligence in its natural state than most wild animals.

Whole herds are driven into ill-concealed enclosures, which no other forest creatures could be got to enter; and though these enclosures are made immensely strong, and are generally capable of resisting the efforts of any single elephant, they would not for a moment withstand the combined attack of even two or three, much less of a whole herd. But elephants never thus combine to free themselves. I have frequently seen fifty or sixty crowded into a stockade only thirty yards in diameter, the palisades of which would have been of no more account than corn-stalks before the rush of three or four of them, but no such rush has been made. More significant still, I have, on several occasions, seen a single elephant in a herd, by a bold dash, burst through the palisade and effect its escape, but I never yet saw any other elephant follow, and the hunters have at once repaired the breach.

When a herd of wild elephants is secured within a stockade, or *kheddah*, the mahouts ride trained elephants amongst the wild ones without fear, though any of the wild ones might, by a movement of its trunk, dislodge the men. This they never do. Single elephants are caught by being bound to trees by men under cover of a couple of tame elephants, the wild one being ignorant of what is going on until he finds himself secured. Escaped elephants are re-taken without trouble; even experience does not bring them wisdom. Almost yearly, one or two elephants of the hunting establishment at Dacca are lost in the jungles by straying or other accident whilst engaged in the capture of their fellows. As an example, in December 1878, an elephant which had been captured three years, and partially trained to hunting, took fright at the fires and guns used in driving a herd and ran away. Her mahout fell off, and nothing more was seen of her until March last, when we re-captured her after four-and-a-half years' absence, in a herd of 21 elephants, 100 miles from where she was lost. She had a calf at heel. When pricked with a spear and ordered to kneel, she did so promptly, and in three days she and another reclaimed runaway were employed in the capture of their fellows. While such facts testify to the docility of the elephant, they tell heavily against its intelligence.

Though possessed of a proboscis which is capable of guarding it against such dangers, the wild elephant readily falls into pits dug in its path; whilst its fellows flee in terror, making no effort to assist the fallen one, as they might easily do by kicking in the earth around the pit. It commonly happens that a young elephant falls into a pit, in which case the mother will remain until the hunters come, without doing anything to assist her offspring, not even feeding it by throwing in a few branches.

In its domesticated state one of the elephant's chief characteristics is, as before stated, its obedience; and it does many things at the slightest hint from its mahout which much impress the on-looker unacquainted with the craft of elephant-guidance. The driver's knees are placed behind an elephant's ears as he sits on it, and it is by means of a push, pressure, and other motions that his directions are communicated, as with the pressure of the leg with trained horses in a circus. It would be as reasonable, however, to credit performing dogs which spell out replies to questions with knowing what they are saying, as elephants with appreciating the objects to be gained by much which they do under the direction of their riders.

Then as to the stories regarding the elephant's reasoning powers, what an improbable one is that of the elephant and the tailor, wherein the animal on being pricked with a needle instead of being fed with sweetmeats as usual, is represented as having deliberately gone to a pond, filled its trunk with dirty water and returned and squirted it over the tailor and his work. This story accredits the elephant with appreciating the fact that throwing dirty water over his work would be the peculiar manner in which to annoy the tailor! How has he acquired the knowledge of the incongruity of the two things, dirty water and clean linen? He delights in water himself, and would, therefore, be unlikely to imagine it objectionable to another. If the elephant were possessed of the amount of discernment with which he is commonly credited, is it reasonable to suppose that he would continue to labour for man instead of turning into the nearest jungle? We commonly use elephants to carry provisions for the hunting parties through the same forests wherein they were disporting themselves as wild animals less than a year ago. That they thus submit must be regarded as more creditable to their good dispositions than to their good sense.

All who have had to deal with elephants will agree that their good qualities cannot be exaggerated; that their vices are few, and only occur in exceptional animals; that they are neither treacherous nor retentive of an injury; and that they are obedient, gentle, and patient beyond all other domestic animals. But it is no traducement of the elephant to say that it is, in many things, a decidedly stupid animal.

Another matter upon which much misapprehension exists is the height to which elephants grow. We hear and read of

Indian elephants 12, 15, even 20 feet high! As a matter of fact, 10 feet in males, and 8 feet 6 inches in females (vertical height at the shoulders, measured as a horse), is very rarely attained, and is not exceeded by one animal in 500. As bearing on this subject, I may quote the following from the "English Cyclopœdia." The Mr. Corse referred to therein was a gentleman thoroughly conversant with the Indian elephant. A valuable paper of his on the subject was read before the Royal Society in 1799.

"During the war with Tippoo Sultan, of the 150 elephants under Captain Sandys, not one was 10 feet high, and only a few males 9½ feet high. Mr. Corse was very particular in ascertaining the height of the elephants used at Madras, and with the army under Marquis Cornwallis, where there were both Bengal and Ceylon elephants, and he was assured that those of Ceylon were neither higher nor superior to those of Bengal."

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"The Madras elephants have been said to be from 17 to 20 feet high. Now let us see how dimensions shrink before the severity of measurement. Mr. Corse heard from several gentlemen who had been at Dacca that the Nabob there had an elephant 14 feet high. Mr. Corse was desirous to measure him, especially as he had seen the elephant frequently at a former time, and then supposed him to be 12 feet high. He accordingly went to Dacca. At first he sent for the mahout or driver, who without hesitation, informed him that the elephant was from 12 to 14 cubits—that is, from 15 to 18 feet high. Mr. Corse measured the elephant exactly, and was rather surprised to find that the animal did not exceed 10 feet in height."

In my own experience I have had some amusing instances of the difficulty of getting at absolute fact in this matter. I have for some years made a point of ascertaining the height of all the largest elephants I have heard of in India. Five years ago I inserted a request for information on this subject in all the chief newspapers of India. Accounts of 11 and 12 feet elephants poured in, but none stood the test of inquiry. To make it worth any one's while to establish such dimensions, I offered to give an order upon any gunmaker for the best double-barrelled rifle, and all accessories, to any gentleman who could produce evidence of an elephant even 11 feet high. This was never done, and I only found one elephant above 10 feet. This magnificent elephant belongs to the Maharajah of Nahun-Sirmoor, in the Punjab, and measures 10 feet 7½ inches in vertical height at the withers. I made a journey of 100 miles in a palanquin to measure him with my own hands. He is the only elephant over 10 feet in height that I have ever seen amongst many thousands, and he must be regarded as not less phenomenal than a human being of 8 feet.

In connection with this subject I may mention that twice round an elephant's fore-foot is his height, within an inch or two; more frequently it is exactly so. Out of many hundreds of elephants of all ages which I have measured, I have only once found the variation to be as much as five inches.

There is at present in the Indian Museum in Calcutta the skeleton of a male Indian elephant which Dr. Anderson, the Superintendent, informed me he thought must have stood about 11½ feet when alive. But this estimate is based entirely on the height of the skeleton as at present set up, which may be, and in my humble opinion is, too great. I unfortunately have not got my note-book, which contains the height of the skeleton, with me in London. The elephant to which this skeleton belonged was shot whilst wild, and therefore could not have been measured when on the ground with any approach to accuracy. It was undoubtedly an exceptionally large animal, but was not over 10 feet, in my opinion, based upon the following consideration. There is now in the British Museum, in South Kensington, a skeleton which I lately brought to England of an elephant which died in June 1833, at Dacca. I measured this elephant most accurately before his death; his height was 9 feet 10 inches at the shoulder. Now, his femur bone measures over all 3 feet 11¾ inches, and is only an inch shorter than that of the skeleton in the Indian Museum in Calcutta. This seems to me to be a reliable ground of comparison between the two, and to be fatal to the claim advanced for the Calcutta Museum elephant of being 20 inches taller than one with a femur bone only 1 inch shorter.

In June 1878 I measured the since famous African elephant, Jumbo. He was then 10 feet 5 inches at the withers, and being about 17 years old, was still growing. I have been unable to ascertain his exact height, measured in the foregoing manner, when he left England for America in 1882. His height was then taken to the top of his back, with his fore and hind feet brought near together. This would tend to arch his back very considerably. He measured 11 feet 6 inches in this way; but as his forefoot planted firmly on the ground measured 5 feet 6 inches, his height at withers was probably about 11 feet. According to Sir Samuel Baker, who has seen large numbers of both Asiatic and African elephants in their native wilds, the Africans, male and female, average about one foot higher than the Asiatic. The case of Jumbo appears to confirm this to a great extent as regards male elephants; but I have never seen African females even as large as Asiatic females. Of course, in captivity we do not see one African to 1,000 Asiatics (taking India into account), so the comparison is unfavourable to the Africans.

Much misapprehension prevails regarding the uses and powers of the elephant's trunk. This organ is chiefly used by the animal to procure its food, and to convey it and water to its mouth; also to warn it of danger by the senses of smell and

touch. It is a delicate and sensitive organ, and is never used for rough work. In any dangerous situation the elephant at once guards it by curling it up. The idea that he can use it for any purpose from picking up a needle, to dragging a piece of ordnance from a bog is, like many others connected with the elephant, founded entirely upon imagination. An elephant might manage the former feat, though I doubt it (I have never seen elephants raise coins and such small articles otherwise than by suction) ; the latter he would not attempt. Elephants engaged in such work as dragging timber invariably take the rope between their teeth ; they never attempt to pull a heavy weight with the trunk. An elephant is powerful enough to extricate a cannon from a difficult situation, but he does it by pushing with his head or feet, or in harness, never by lifting or drawing with the trunk. Elephants do not push with the forehead or region above the eyes, but with the base of the trunk or snout about one foot below the eyes.

I may here mention that I have seen many instances of very severe injury to their trunks amongst wild elephants. These were evidently caused by the sharp edges of split bamboos whilst the animals were feeding. Some have had from a few inches to a foot of the member totally useless, merely hanging by a little muscle, both nostrils having been cut through.

The age to which the elephant lives is, as must ever be the case with denizens of the forest, uncertain. The general native opinion is that they attain 120 years in exceptional cases (they have been known to reach this age in captivity), but more usually to 80 years. Under the more favourable conditions of a natural life the elephant must attain a much greater age than in captivity. I think it by no means improbable, looking to their peculiar dentition and other circumstances, that elephants live to 150 or 200 years, but this view is, of course, to a great extent a supposition.

One of the most remarkable facts in connection with wild elephants is the extreme rarity of any remains of dead ones being found in the jungles. This circumstance is so marked as to have given rise to the belief amongst some wild tribes, that wild elephants never die ; whilst others believe that there is a place, unseen by human eye, to which they retire to end their days. The latter belief is untenable, as there are no parts of the forests of India that are not well known to, and occasionally visited by, the wild tribes who inhabit them.

In my own wanderings for many years through elephant jungles I have only seen the remains of one female elephant that had died in giving birth to a calf, and of one elephant drowned in a mountain torrent. Not only have I never seen the remains of an elephant that had died a natural death, but I never met anyone amongst the jungle tribes or professional elephant hunters who had.

Sir Emerson Tennent says in his work on Ceylon :—"The natives generally assert that the body of a dead elephant is seldom or never to be discovered in the woods. And certain it is that frequenters of the forest with whom I have conversed, whether Europeans or Singhalese, are consistent in their assurances that they have never found the remains of one elephant that had died a natural death. A European gentleman, who for 36 years without intermission had been living in the jungle, ascending to the summits of mountains in the prosecution of trigonometrical surveys, and penetrating the valleys in tracing roads and opening means of communication—one, too who had made the habits of wild elephants a subject of constant observation and study—has often expressed to me his astonishment that, after seeing many thousands of living elephants in all possible situations, he had never yet found a single skeleton of a dead one, except those which had fallen by the rifle. The Singhalese have a superstition in relation to the close of life in the elephant; they believe that, on feeling the approach of dissolution, he repairs to a solitary valley, and there resigns himself to death."

(To be continued.)

LONDON TEA COMPANIES.

(Arranged according to area of cultivation).

Results of working in 1883.

Name.	Capital paid up.	Acreage of cultivation.	Capital per acre.	Crop of 1883.
	£		£	lbs.
Assam Company, ...	187,160	7,600	25	2,569,961
Land Mortgage Bank of India, *Limited,*	308,468	6,645	46	1,539,120
Jorehaut Tea Company, Limited,	100,000	4,000	25	1,099,813
Darjeeling Company, Limited,	135,420	1,562	88	473,810
Doom Dooma Tea Company, Limited, ...	113,600	1,466	78	895,155
Indian Tea Company of Cachar, Limited, ...	94,060	935	100	195,040
Lebong Tea Company, Limited,	82,070	988	83	77,899
Borelli Tea Company, Limited,	78,170	875	90	396,000
Jhanzie Tea Association, Ltd.,	35,000	783	45	264,110
Scottish Assam Tea Company, *Limited,*	*79,590*	*679*	*117*	*225,925*
Dejoo Tea Company, Limited,	43,580	556	78	201,248
Borokai Tea Company, Limited,	43,560	850	51	212,720

Name.	Yield per mature acre.	Cost of tea per lb.	Value of tea per lb.	Profit per acre.	Dividend on 1883 crop.
	lbs.	s. d.	s. d.	£ s. d.	per cent.
Assam Company, ...	339	0 11½	1 1	3 8 5	14
Land Mortgage Bank of India, Limited, ...	231	1 0½	1 3½	2 17 2	nil.
Jorehaut Tea Company, Limited, ...	303	1 0½	1 3½	3 18 1	12½
Darjeeling Company, Limited, ...	303	1 1¼	1 6½	6 14 0	7½
Doom Dooma Tea Company, Limited, ...	617	0 10½	0 11½	2 12 8	2¾
Indian Tea Company of Cachar, Limited, ..	287	1 0¾	1 4½	2 13 0	3
Lebong Tea Company, Limited, ...	291	1 0½	1 5⅖	7 0 0	9
Borelli Tea Company, Limited, ...	535	0 10¼	1 2	7 17 0	8
Jhanzie Tea Association, Limited, ...	365	1 1¾	1 2¼	2 11 3	5½
Scottish Assam Tea Company, Limited, ...	337	0 11	1 4½	7 15 2	5
Dejoo Tea Company, Limited, ...	390	0 11¼	1 3½	6 13 9	7
Borokai Tea Company Limited, ...	265	1 0	1 8	9 3 7	15

—*Indian Agriculturist.*

BELERIC MYRABOLAMS.—A small sample of these, the produce of the *Terminalia Belerica* (*Tandra*, Tel.) collected in Kurnool was lately sent through Messrs. Arbuthnot & Co., for valuation in England. It was reported that, before the use of them was better known, they sold at £4 to £5 per ton, the present value being £7 to £8 for quantities of 20 to 50 tons.—J. S. G.

MUSICAL WOOD.—Wood has properties that are not only productive of music, but of the different qualities of music. Were it not for wood some of the noblest of instruments would be unknown; there would be no violin, the only instrument that fitly portrays the emotions of the musician; no guitars, which have twanged so often to the sentiments of love; no organs, which swell the chorus of devotion; no pianos, which, next to the violins, stand at the head of all musical instruments. So much is there in the musical quality of wood that at least one man in the United States has spent a lifetime in experimenting with it and studying it.

The violin from the first has not been improved. Efforts have been made to add to its merits, but without success, for nothing could be added. It was born perfect. Nothing will answer in its construction but spruce and maple. Recently a violin maker experimented with cypress for the belly, but decided that it would not answer the requirements.

The manufacture of musical instruments consumes a large amount of lumber, probably 125,000,000 feet a year in the United States, including packing cases; and this estimate may be too low. Wishing to know what kinds of wood are used in pianos, and to what extent, a representative of the *Lumberman* visited the factory of Messrs. N. Goold and Son, corner of Grove Avenue and Twenty-second Street, this city, for that purpose—a firm, by the way, that turns out instruments of so high a grade that they are sought and sell readily as fast as finished without any resort to advertising. This concern has recently erected a factory with a capacity of from 40 to 50 pianos a month. This makes six factories in Chicago. There are other dealers who claim to manufacture their instruments here, but their factories cannot be found this side of the East, where there are immense establishments that make stock work and stamp any name on the instrument desired.

There are used in pianos ash, spruce, whitewood, cherry, rosewood, mahogany, ebony, cedar, boxwood, white holly, bird's-eye maple, rock maple, American and French walnut, birch, chestnut, rock elm, oak, basswood, pine and gum. All of these woods are not used in any one instrument; they are variedly used according to the ideas of the manufacturer and the style of finish that is given to the case. Cherry, to any extent, has not been made much use of until of late. A few years ago such a thing as an ebonized case was a novelty, but now quite a proportion of all the instruments made are finished in black, and there is no hardwood that can be ebonized better than cherry. Necessity brought about this change. Rosewood is produced in a much warmer climate than this, consequently it will not stand the sudden changes from heat to cold without cracking. It is not unusual for a costly instrument when veneered with rosewood to become disfigured in a few years. It is owing to the same principle that American marble is taking the place of Italian to such an extent. Italian marble is indigenous to a warm climate, and in this country soon changes in colour and checks. An ebonized cherry piano case is good for a lifetime, and when it begins to look old it can be put in good shape again at small expense.

Spruce is invariably used for piano sounding boards, and pine for the sounding boards of organs. Here is one place where the different qualities of wood are seen. A soft tone is required in an organ, and a soft wood is used to produce it. In pianos a harsher tone is required, and to produce it a harsher

and harder wood must be used. There are factories in the East that do nothing but turn out piano sounding boards, and one of these manufacturers, Mr. Alfred Dolge, of Dolgeville, N.Y., recently sent a communication to a musical journal, in which he said that if the State carried out the desire of the parties who are harping on the denudation of the Adirondacks, and forbade the cutting of all timber in that region, the piano manufacturing interest would be wholly at a loss where to procure spruce for sounding boards, and hard maple for other portions of the instrument, for, with the exception of the Black Hill forests of Montana, the above-named species, with their peculiar qualities, cannot be found in the United States or Canada. The *Lumberman* is of the opinion that this statement by Mr. Dolge is far-fetched. He is certainly wrong in regard to maple ; and some manufacturers are using spruce that never saw the Adirondack region that answers the purpose admirably.

In the cheaper class of instruments pine is used for the frame of uprights, and in the East chestnut is used for this because it is cheaper than ash, but the best manufacturers who aim at strength and solidity employ hardwood. The tone of an instrument depends to a certain extent upon this. It also depends to some extent upon the character of the cabinet work. On the best pianos none but the best cabinet-makers are employed, and the lumber must be thoroughly seasoned. It is on record that a maker of cheap pianos received a lot of lumber, and in ten days it was made into piano cases ready for the market. Not much can be expected of such instruments. The cases shrink, crack, or become unglued, either of which affects the tone. There must be nothing about the case of an instrument that will vibrate when a key is struck ; if there is, there is a rattling that is unpleasant. The manufacturers who are the most careful of their reputation say that a first-class piano cannot be turned out inside of three or four months.

Birch is sometimes used for cases instead of cherry. Gum has not been much used yet, but it finds favour in some directions because it is so easily grained ; and it may be mentioned that graining is done so perfectly now that it would be easy for a dealer to sell a grained case for a rosewood veneered one. Even an expert has to look closely to detect the difference. If a dealer were to do this he would not be guilty of much of a crime, for the purchaser would be the better off in the long run. Cedar is used for the hammer shanks.

It is estimated that there are made in the United States 50,000 pianos annually, and every piano calls for 500 feet of lumber. If measured up this amount of lumber would not be found in a piano, but in its manufacture there is a great deal that necessarily goes to waste. This would give the total amount of lumber used in this industry as 25,000,000 feet yearly ; besides, nearly every instrument must be furnished with a packing case.—*North-western Lumberman.*

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A SHORT ACCOUNT OF THE FORESTS OF THE NORTHERN FOREST CIRCLE, MADRAS PRESIDENCY.*

THE *chief forest tracts* in the Northern Circle are the following:—

Ganjam District.—In the Goomsur Taluk, including Suradá, are large sál (*Shorea robusta*) forests, the best portions of which lie at the foot of the Ghát range in the valleys of the Gullery and Mahanadi rivers and on the boundary of the Puri district in the Kriyamba valley. The sál tree chiefly occurs on the level lands and in the valleys and lower slopes of the hills, the upper slopes being covered, where dry, with forest of bamboo and deciduous trees, and where ravines occur, with evergreens and large specimens of the mango (*Mangifera indica*). The chief allies of sál in the plains are the sahájo (*Terminalia tomentosa*), dhau (*Anogeissus latifolia*), holondha (*Adina cordifolia*), and ebony or kendhu (*Diospyros tomentosa*).

The satinwood (*Chloroxylon Swietenia*) also is occasionally met with, while in the poor 'kankar' lands, which here and there alternate with the richer sál-producing soils, the sohan (*Soymida febrifuga*) grows to a large size. The prevalence of the mango and tamarind is most noticeable, and leads to the suspicion, otherwise also borne out by the homogeneous growth of the sál forests and the rocky nature of the hills, that it is not long since the whole country was under cultivation. The slopes of the Eastern Gháts which surround Goomsur on the west and south are clothed with a damper vegetation, and here the sál may be seen ascending to from 2,000 to 3,000 feet in altitude. Large and lofty forest trees cover these slopes, and in wetter places are especially found the tangani (*Xylia dolabriformis*) and the toon (*Cedrela Toona*). The forests of Goomsur are in better actual condition than those of Suradá, for the better means of

* Appendix to a catalogue of the collections of forest products exhibited by the Northern Circle, Madras Forest Department, at the Edinburgh Forestry Exhibition. By J. S. Gamble, Conservator of Forests, Madras.—[ED.]

rafting afforded by the larger river of the latter, the Rushikulya, has led to a greater export and especially of firewood and sál poles.

In the Berhampore Taluk, near the sea and close to the town of Berhampore, are the forests of the Mohiri Hills, capable of great improvement and great utility, though at present worked beyond their means. The hills are inhabited by Sauras who live by 'kumri' cultivation, and the constitution of reserves is therefore difficult. The chief tree in the Mohiri Hills is tangani (*Xylia dolabriformis*): the sál does not occur.

The Agency Tracts of Goomsur and Chinna Kimedi under Government, as well as those of Pedda and Parlá Kimedi and Bodogodo under Zemindars, are covered with forest in the less frequented parts. Large sál is very common, and is to some extent exported, but the absence of export roads from the ghâts will prevent much denudation for some time to come, and before that time does come, it is to be hoped that arrangements for proper conservancy and management will have been started. Rules have already been framed for the Parlákimedi Zemindari, at present under the Court of Wards.

Most of the zemindaries contain considerable areas of forest land; but very little care of the forests is taken, and they are consequently rapidly deteriorating. Noticeable are the forests of the Mahendragiri slopes rising to nearly 5,000 feet in the estates of Mandasa and Budarsing, but they are much denuded by 'kumri' cultivation. The upper parts are covered with 'sholas' as in the Nilgiris, and the lower with forests, the principal tree in which is the tangani (*Xylia dolabriformis*). As in the Goomsur Hills, the mango and tamarind as well as the 'solopo' palm (*Caryota urens*) are greatly prized by the Khonds and Sauras, the latter as a toddy-yielder. Along the coast are occasional stretches of scrub forest, some of which will be protected as 'Fuel and Fodder Reserves,' and in the vicinity of important seaports like Ganjam, Gopálpur and Calingapatam, it is proposed to make plantations of casuarina.

The Goomsur forests were visited by the Conservator in 1859 (Dr. Cleghorn), 1864 and 1875 (Colonel Beddome) and 1884 (Mr. Gamble), and after the latter's visit proposals were made for selecting large areas in Goomsur and Suradá for constitution as reserved forests. The Mohiri and Mahendragiri Hills and the Parlákimedi Estate were also inspected. Five ranges were constituted at Berhampore, Suradá, Mojogodo, Kukuluba, and Kurcholy. The head-quarters are at present at Russellkonda, where is the chief depôt for the sale of timber. Forest houses have been built at Russellkonda and Suradá, and others are in course of construction. Most of the timber goes in the form of sleepers to Calcutta, but there is also a considerable local demand at Aska, Berhampore, and Gopálpur.

Vizagapatam District.—The conditions of forest work in this

district are much the same as in Ganjam. The Government forests lie in the Pálkonda Hills to the north, in the Golgonda Hills in the south-west, and in the coast taluk of Sarvasiddhi. The rest of the country is zemindari land, and the largest of the estates, Jeypore, has very considerable areas of forest similar to that of the Agency Tracts of Ganjam. The Pálkonda forests were examined in 1884; they contain large areas of young forest, with an abundance of tangedu (*Xylia dolabriformis*), bella (*Chloroxylon Swietenia*) and other good trees along the slopes to the south-west, overlooking the Pálkonda Taluk, while within are good patches of gugilapu (*Shorea robusta*), noticeable among which are those at Voni and Lakshmipuram, which have been for some time carefully protected. Proposals for constituting reserves were made to the Collector, and it is probable that before long these forests will yield considerable material for the supply of the taluks of the Vizianagram Sub-division and the Chicacole Taluk of Ganjam.

The forests of the Golgonda Taluk lie partly in the plains, but chiefly in the hills of the main range of the Eastern Gháts which rise to 4,500 feet. The chief trees are the Konda tangedu (*Xylia dolabriformis*) and the Nalla maddi (*Terminalia tomentosa*). Mr. Welsh, the Sub-Collector, states that bamboos are also exported as well as myrabolams, the produce of the karakai (*Terminalia Chebula*). The people bring out leaves for plates. Teak (*Tectona grandis*) is scarce, and is also chiefly found only towards the Godávari. These forests are being inspected for the constitution of reserves. In the Sarvasiddhi Taluk, according to Mr. Welsh, there is an extensive area of waste land, which will now be utilized partly as 'Reserved Forests' partly as 'Fuel and Fodder Reserves.' This land consists chiefly of stony hills, which stretch down to the sea, and adjoining the Government lands, are those of the Pandúr, Mallavaram estate, now under the Court of Wards, where some attempt at conservancy has been started.

In the Párvatipur Sub-division there are still some patches of sál forest rapidly being denuded, and the hills along the sea-coast about Bimlipatam and Vizagapatam, in the Vizianagram Zemindari chiefly, would repay protection.

A forest division has lately been constituted and two ranges formed, the head-quarters being at Vizagapatam.

Godávari District.—Of the forests of this district little is yet known except of those in the taluks of Rékapalle and Bhadráchalam on the Godavari. These latter, which really continue the Golgonda Hills of Vizagapatam and adjoin the Rampa Hills, have been for some time under the conservancy which was started when they formed part of the Central Provinces. The chief tree is teak (*Tectona grandis*), but other good kinds are found, and notably Konda tangedu (*Xylia dolabriformis*), which here nearly reaches its southern limit on the east coast. Twelve

reserves, said to contain 68 square miles, have been constituted, but these will have to be increased if a proper area is to be secured. Of these, the Ghandigudiem reserve is said to be the best, but their capabilities are as yet very little known. There are considerable areas of waste land in the taluks of the Godávari delta, which will shortly be examined and reported on. The head-quarters of the division are at Rajahmundry, a Forest Ranger resides at Dumagudiem, and other ranges will be constituted as required.

Kistna District.—The forests of this district are somewhat scattered, but the chief areas lie in a block towards the west in the Palnád, Vinukonda and Sattenapalle Taluks. The chief tree in these forests is the yépi (*Hardwickia binata*), but a small amount of teak is found as also is the Konda tangedu. Their present condition is not very good, chiefly on account of their having been too much grazed over, but they will improve under protection. The chief forests are those of Bollapalli in Vinukonda, those bordering the Kistna river in Palnád and Venkatayyapalem in Sattenapalle Taluk. In the Bezváda and Nandigáma Taluks lie the Kondapalli and Kottur forests with some smaller areas near Bezváda itself. In the Narsaraopet Taluk is the isolated hill range of Kondavíd, now only covered with scrub chiefly of custard apple (*Anona squamosa*), but capable of improving; while in the Guntúr taluk the chief forest areas are in the plains, on old cultivated land, and growing Nulla tumma (*Acacia arabica*). In the Bápatla Taluk there is a large stretch of forest land near the coast producing soap-nuts (*Sapindus emarginatus*), while a similar area existed in Gudiváda, which, having lately been leased out, has now almost disappeared. About the mouth of the Kistna are large extents of mangrove swamp, the principal tree in which is the mada (*Avicennia officinalis*), and these forests furnish great quantities of fuel for the supply of Masulipatam. In the taluks of Gudiváda, Bandar, Répalle and Bápatla many plantations were formed by the Jungle Conservancy Fund, chiefly of casuarina (*Casuarina equisetifolia*), but also of other species, such as vepa (*Melia Azadirachta*) and dirisana (*Albizzia Lebbek*) with the palmyra palm (*Borassus flabelliformis*). Some of these plantations, as was to be expected at the outset, have proved failures, while others, and especially those of Karlapálem and Warderevu, may be expected to produce a considerable amount of useful material.

Proposals for the formation of 'Reserved Forests' are now being submitted to Government, and it may be hoped that after time has been allowed for the improvement of growth, the Kistna forests will be most valuable for the supply of the thickly populated agricultural country of the Kistna delta. The head-quarters of the division are at Masulipatam, and ranges have been formed at Bandar, Bápatla, Bezváda, Guntúr, Vinu-

konda, Palnád, and Krosúr. Portions of the district were visited in 1883 by the Conservator.

Nellore District.—The chief range of forest country in this district lies along the Veligonda Hills, on the eastern slopes of the range in the taluks of Rapúr, Átmakúr, Udayagiri, and Kanigiri, in blocks alternating with zamindari lands, chiefly belonging to the Kálahasti and Venkatagiri Estates. In these forests the red sanders tree (*Pterocarpus santalinus*) occurs, as well as the yépi (*Hardwickia binata*), yegi (*Pterocarpus Marsupium*) and teak with other valuable kinds. They have now been proposed for constitutions as reserved forests. The isolated hill ranges of Udayagiri, Kanigiri, and Chimakurthi have also been so proposed and settlement is in progress.

The next in importance of the forests of the Nellore District is that of Sríharikóta on the islands of the Pulicat lake and the belt of land between the lake and the sea. This forest has long been worked for the supply of the Madras market in fuel. The chief trees are the nerudu (*Eugenia Jambolana*), solagu (*Pterospermum suberifolium*), and mushti (*Strychos Nux-vomica*). Soap-nuts are also found and tamarind trees in great number. The chief product is fuel, and for this the forest block for the year is cut, the trees being pollarded only and not cut to the ground. For the purposes of working eight blocks are formed, and these are cut in rotation. Minor produce also is largely exported, such as tamarinds, strychnine seeds, orchil (*Rocella Montaignei*) and the dye-plants, chay (*Oldenlandia umbellata*) and surati chekur (*Ventilago Madraspatana*). Canes, the produce of *Calamus Roxburghii*, are also sent to Madras for sale.

In the plains taluks of Gúdúr, Nellore, Kávali, Kandukúr and Ongole, the forests consist of areas of scrub, some of which, however, and especially those reserved near Nellore and Ramapatam, are in good growth, and valuable for fuel and poles and the small wood, which is the most necessary for native use. Out of these areas reserves are being selected, but all are under management under the forest rules. The chief fuel trees are the chikreni (*Albizzia amara*) and pala (*Mimusops indica*), but the number of kinds is large and there are many others of value.

Very important also in the Nellore District are the casuarina plantations, the chief of which are at Dugarázpatnam, Kottaaptam, Tamminapatam, Utukur, Tummulapenta, Ramapatam, and Kanuparti. Some of these were started by the Salt Department, the rest by different previous Collectors, but the credit of the good work done is chiefly due to a Sub-Assistant Conservator, Somasundrum Moodelly, who was previously for many years under the Jungle Conservancy Department.

These plantations cover about 2,000 acres of land on the sand dunes of the sea-coast, and are now coming into working.

Recent investigations go to show that these plantations make annually an increment of about 4½ tons per acre, up to eight years of age, and that about 5,000 tons may yearly be made available. Arrangements for their survey and a proper working scheme are in progress. A number of palmyra plantations, and one of cocoanut (*Cocos nucifera*) have been made, while many topes have been planted about the district. In some, the cashew-nut (*Anacardium occidentale*) is grown, and the nuts exported for sale. The head-quarters of the division are at Nellore, and range head-quarters at Sríharikóta, Nellore, Rapúr, Udayagiri, Kanigiri, Ongole and Ramapatam. The produce of the Sríharikóta forests and the plantations is taken for sale to a central depôt in Madras.

Cuddapah District.—In this district, forest work has perhaps been longer set on foot than in most others in the northern circle. There are forests in all táluks, but the chief areas are those of the Pálkonda Hills, the Seshachellum Hills, the Veligonda range, the Lankamalai Hills, the Nallamalias, the Yerrámalia or Jammalamadugu Hills, and the scattered hills of the Kadiri and Madanapalle Taluks. On the Pálkonda Hills, red sanders (*Pterocarpus santalinus*) is the chief tree, but teak of small size is not uncommon with yépi (*Hardwickia*) and other species. In the valleys are large mango and fig trees. Owing to great demand for the railway supply, jungle fires, over-grazing, and excessive lopping of leaves for manure, these forests are reduced to small trees and scrub only, but large areas have now been proposed for reservation, and with careful protection, especially from fire and goats, they will rapidly improve, and indeed even now show promise of great value. It is probable that there is no more valuable wood in India, except sandal, than red sanders, and it is well that that tree was specially selected for prohibition of felling some years ago, for otherwise there would be very few left. The Seshachellum Hills are very similar in growth, and indeed so also are the Veligondas and Lankamalais, in the former of which the thamba (*Shorea Tumbuggaia*) and jalari (*Shorea laccifera*), both valuable timbers, similar to the sál, occur.

The forests of the Nallamalai Hills enjoy a better soil, and the growth is consequently better. In the hills of the Kadíri, Madanapalle, Ráyachóti, and Váyalpád Taluks red sanders does not occur, and it is probable that the chief tree is the yellema (*Anogeissus latifolia*). Lying at the head of the valley of Pullampet between the Pálkonda and Veligonda Hills are the Ballipalle evergreen forests, which are being regularly worked for the supply of the Madras Railway. The best trees are the ebonies, satinwood, pala (*Mimusops indica*), and acacias, while many large clumps of bamboo, the large one (*Bambusa arundinacea*) in the plains, the small kind (*Dendrocalamus strictus*) on the adjoining hills, are much cut and exported. In this

district there are many experimental plantations, chiefly made in order to find out the best system of re-clothing bad soils. They have not been always very successful, but have afforded some experience, and some of them are doing well. The red sanders plantation at Kódúr has done very well indeed, and the only regret is that the area is not much larger. It was started in 1865 by the then Forest officer, Mr. Yarde, and the trees are now about 42 feet high with a mean girth of about 18 inches, the average yearly increment so far having been about 3 tons per acre.

The Cuddapah District has many topes, mostly along roads, and of good growth, when it is considered that the best soils were not always chosen.

Large areas have been proposed as reserved forests in most táluks, except Jammalamadugu, which has not yet been finally reported on, and the settlement is in progress; the Thanakonda reserve so far with one or two plantations has alone been finally notified, but the large Settikunta reserve has also been completed.

The chief works in the district, are the supply of the railway, which is done by contractors, and the collection and sale of red sanders roots and pieces for export. About 1,500 tons are brought out annually, valued at about Rs. 18,000. The wood is sent to England as a dye, probably as a substitute for log-wood. Among other important products the chief is the tangedu bark (*Cassia auriculata*) which is very common, and of which large quantities are exported for tanning. The Cuddapah forests, altogether, are of great importance, and their position, bordering a line of railway, gives them a high value, independently of that conferred by their usefulness in protecting the hills and the sources of the streams. The head-quarters of the division are at Cuddapah, of the Assistant Conservator at Kódúr, and of the ranges at Kódúr, Rajampet, Cuddapah, Proddutur, Siddhavattam, Badvél, Ráyachóti, Váyalpád, Kadiri, and Madanapalle. There are three forest houses at Kódúr, Sanipaya, and Horsleykonda, and more are projected, as well as good roads to open up the forests.

Kurnool District.—The principal forest area in Kurnool is the great range of the Nallamalai Hills, which continue the portion referred to as coming in the Cuddapah District northwards to the Kistna river and the frontier of Hyderabad. These hills contain a very large extent of forest of various descriptions. The main range of hills has its slopes covered with bamboo and deciduous trees, chief among which are the chiriman (*Anogeissus latifolia*) and occasional jitegi (*Dalbergia latifolia*). In the hot weather season trees with showy flowers are conspicuous, such as the gogu (*Cochlospermum Gossypium*), modugu (*Erythrina indica*), and buruga (*Bombax malabaricum*), while these brilliant colors are set off by the white-barked smooth stems of (*Sterculia urens*). The valleys contain teak in considerable quantity

though not very large, as well as other valuable trees such as the nallamaddi (*Terminalia tomentosa*) and yegi (*Pterocarpus Marsupium*), while perhaps most conspicuous of all are the fine ippa (*Bassia latifolia*) whose flowers are eaten by the Chentzus, the jungle tribe of these hills, and the pandra (*Terminalia Belerica*) left uncut as it is considered unlucky. On the eastern side yepi (*Hardwickia*) of good size is not uncommon. Towards the north this tree is also the chief species of the plateaux, which border the Kistna river and adjoin the forests of the Kistna District, but there it is as much smaller as the soil is poorer. Near the temple of Srishalam, close to the chief gorge of the Kistna river, sandalwood (*Santalum album*) occurs, but of very slow growth. The Nallamalai forests occupy portions of five taluks, *viz.*, Nandikótkur, Nandyal and Sirvel on the west, Márkápur and Cumbum on the east.

A small portion of the Veligonda Hills comes into this district as well as into Cuddapah and Nellore, and gives a small quantity of red sanders, while there are several isolated hills in the Cumbum and Márkápur Taluks, presenting, however, but poor growth compared to that of the Nallamalais. West of the Nallamalais and between the towns of Nandyál and Kurnool, and running also southwards into the Cuddapah District, are the Yerramalai Hills. These hills have been very much grazed over, and the forest growth is chiefly of poor and thorny kinds; it is however expected to improve on the selected areas, which will be constituted reserved forests.

The greater part of the Nallamalai Hills is under settlement as 'Reserved Forests,' as are some blocks in the Veligondas, but the setttement will take some time.

Of plantations there are none, but there are many good topes along the chief roads, which in future years will form good camping-grounds. The head-quarters of the division are at Nandyál, and ranges have been made at Cumbum, Márkápur, Nandikótkur, Sirvel, Nandyál, and the Yerramalais. Forest houses are in course of construction in the Nallamalais, where they are necessary on account of the bad climate, and export roads will soon be started.

Timber is not brought out departmentally, but purchased by contractors, who themselves export to the plains country and the districts of Kistna and Bellary. Minor produce is not much collected, as so much of it is used locally by the Chentzus. The main river-crossings from Hyderabad are watched, and passes checked under recently sanctioned rules.

Bellary District.—In forest capable of giving much produce at present this district is very poor, though areas of fair size have been selected on the Copper Mountain Range near Bellary, and in the táluks of Hospet, Ráyadrúg and Kudligi, to be constituted reserved forests. At present most of these forests are very bare, though in places, and notably at Malpangudi, where

it has been long protected, there is a fair growth of yepi (*Hardwickia binata*). Some areas, especially in the Adóni and Álúr Taluks, have also been selected, on which is a growth of babúl (*Acacia arabica*). But the chief forests of Bellary lie in the Sandúr State, from the Rajah of which a lease has been taken of 40,000 acres in three ranges round the Sandúr valley and the station of Rámandrug. These forests have a good vegetation, especially on the summit of the plateau, where about 1,500 acres of compact growth is found. On the slopes the forest is mostly deciduous, with teak, ebony, *Terminalia tomentosa*, and other trees, with some sandalwood.

Towards the base where more cutting has gone on the growth is naturally not so good. Great endeavours are being made to protect these forests from fire, and these endeavours have so far been successful. If they can be kept up permanently the forests of Sandúr will soon become very important.

The forest head-quarters are at Bellary, and ranges have been formed at Sandúr, Kudligi, Hospet, and Ráyadrúg.

Anantapur District.—In character the forests of this district resemble those of Bellary and of the southern táluks of Cuddapah which they adjoin. The chief forests lie in the hills of Penukonda and Hindupur where there is a good growth and in places teak, yepi (*Hardwickia*), *Anogeissus latifolia*, and other deciduous trees occur. Some good areas have been selected and proposed as reserved forests. Further north is the Muchukóta forest on the hills which separate the Tadpatri and Anantapur Taluks. This has been for some time under protection, though the keeping out of fire has been found to be difficult. The chief tree in the forest is the *Hardwickia binata*, and its general appearance is that of scattered poles of the tree with a few of other species.

There are a few topes and small plantations of babúl in this district, but the chief is that near Gooty, where there is a good growth of babúl (*Acacia arabica*) with *Acacia leucophlæa*, *Albizzia Lebbek*, the palmyra palm, and other trees of about 400 acres.

The head-quarters of the forest division are at Anantapur, and ranges have been formed at Penukonda, Hindupur and Muchukóta.

Nilgiri District.—The forests of the Nílgiris are of four kinds—

1. The eastern and southern slopes.
2. The northern slopes and Moyar valley.
3. The south-east Wynaad.
4. The 'sholas' on the plateau.

In the first, we find deciduous forest with teak, anogeissus, terminalias and other trees on the projecting *spurs* and slopes of southern aspect, while the valleys are filled with fine forest of partly evergreen, partly deciduous growth. In these valleys

the chief tree is the vengai (*Pterocarpus Marsupium*), but noticeable among others are *Mesua ferrea, Cedrela Toona, Chikrassia tabularis* and *Bischoffia javanica*. The second category contains chiefly deciduous forests with a fair amount of sandalwood, and the third, similar forest to that of the Malabar Wynaad, showing trees of large size, chief among which are teak and blackwood (*Dalbergia latifolia*). The forest of the 'sholas' is quite different. These 'sholas' are patches of thick forest along ravines and water-courses and separated by grass-lands or downs. The forest is low, the trees rarely reaching 50 to 60 feet in height, and the most important trees are three Eugenias (*Eugenia montana, Arnottiana* and *calophyllifolia*), two hollies (*Ilex denticulata* and *Wightiana*), *Michelia nilagirica, Ternströmia japonica, Gordonia obtusa, Meliosma pungens* and *Arnottiana, Mappia fœtida* and species of *Symplocos, Microtropis, Viburnum* and *Ligustrum*. In all catagories are reserved forests being selected for reservation. These 'sholas' are very slow-growing, and old trees do not easily reproduce, so that when it was found that they were likely to be in danger of destruction for fuel, arrangements were made to plant the quick-growing Australian wattles and gums. Plantations of the blue gum (*Eucalyptus globulus*) and the wattles (*Acacia Melanoxylon* and *dealbata*) have been formed near Ootacamund, Coonoor and Wellington, and the chief of them are 'Aramby' and 'Bathri' at Ootacamund, 'Old forest' and 'Bandyshola' at Coonoor, and 'Rallia' near Wellington. These trees, and especially the blue gum, grow very fast, and are fit to cut at ten years of age, being then often 100 feet high with a girth of 2—3 feet or even more. The annual increment of blue gum has been ascertained to be about 12 tons per acre per annum, that of wattle 6 tons. These plantations are being worked in regular rotation for the supply of fuel on the plateau.

The produce of the Wynaad and Moyar forests consists of teak logs, which are brought for sale to Ootacamund, sandal-wood roots and myrabolams. The head-quarters are at Ootacamund, and ranges have been formed at Coonoor, Kótagiri, Naduvatam, Sígúr, Mudumalai and Mailur.

The northern circle was only constituted in December 1882; before that time the Ganjam, Nílgiri, Cuddapah and Kurnool forests were alone under the Forest Department, the rest having been managed by the Jungle Conservancy Fund now abolished.

The area of reserved forests constituted under the old system was 812 square miles on 1st April, 1883, but this is by no means a correct estimate, for several large tracts are omitted. No reserved forests have yet been finally formed under the new Act.

The revenue and expenditure of the last two years have been—

Years.	Revenue.	Expenditure.	Surplus.
	Rs.	Rs.	Rs.
1882-83, ...	3,89,112	2,51,323	1,37,789
1883-84, ...	4,13,333	3,02,452	1,10,881
Average, ...	4,01,222	2,76,887	1,24,335

The chief districts in which revenue is realized are Cuddapah, Kistna, Nellore, Kurnool, Nílgiris and Ganjam. The sales of sál timber in Ganjam, of red sanders and railway fuel in Cuddapah, of fuel in Nellore, of sandalwood and teak in the Nílgiris, largely help to make this up, while under recent rules the general receipts may by expected slowly to improve.

J. S. GAMBLE.

WATTLE CULTIVATION AS AN INDUSTRY.*

By Acacia.

It is no exaggeration to say that the various kinds of acacia usually spoken of under the general term of wattles form one of the most valuable of the natural products of Australian soil. The bark of these trees has for years occupied an important position in the tanning industry, and it may safely be said that the estimation in which it is held is on the increase rather than declining. Side by side with this fact is the important and somewhat distressing circumstance that the yield of bark appears not only to be on the decrease in quantity but also in quality. The reason of this falling-off is not far to seek. In the early days of wattle-stripping the procuration of sufficient bark to meet all requirements was accomplished with comparative ease, inasmuch as wattles were to be found growing here, there, and everywhere. So widespread was the natural habitat of the various sorts of acacias in South Australia that, within the settled districts at all events, it is more difficult to define localities where it did not and would not grow, than to name localities where it would and did thrive. A very large proportion of the unalienated lands was more or less covered with wattles, and so great was the area, that strippers could find a great deal more bark than they had time to strip. Gradually, however, as these lands were parted with by the Crown, the natural growth was burnt off to make way for sheep or wheat, until, as is now the case, wattles are considerably reduced

* From the "South Australian Register," May 15th, 1884.

numerically, and are only to be found in certain portions of the original area. As a result of this reduction the price of bark went up to a high figure, and the occupation of stripping and selling bark has now become such a profitable one, that strippers pursue their avocation without the smallest discrimination whatever, utterly regardless of the state of the bark when gathered, and quite oblivious to the future supply. Every available wattle-tree within easy distance of a commercial centre is denuded of its bark, and by this wholesale destruction thousands of young trees of perhaps not more than three or four years' growth are cut off before their prime. Such sinful waste cannot be too severely condemned. The bark from these young trees is much inferior in quality to those of mature growth, while the presence of so much juvenile bark in the market, mixed as it usually is with that of better quality, must necessarily tend to lower the value of the whole product in the estimation of the tanning industry. Moreover, it is in the primary stages that the growth of this tree is slowest and the accumulation of tannin at its minimum. As the tree advances in years the proportional growth per annum gradually but surely increases both in bulk as well as in the production of tannin. Such facts as these should not be lost sight of by all who are fortunate enough to possess natural wattle plantations, and should deter them from permitting any premature stripping on their estates. The time has now arrived when the systematic preservation and cultivation of wattles as an industry will be attended with most profitable results—results which I firmly believe will place wattle-growing in the front rank of colonial industries from a lucrative point of view.

Of the acacias which produce the wattle or mimosa bark of commerce there are two species which stand pre-eminent in this colony. These are *Acacia Pycnantha* and *Acacia decurrens*. The habitat of the former ranges chiefly from the Adelaide hills north as far as Beltana. North of Spalding, however, this species assumes a somewhat stunted form compared with what we are accustomed to see in the Adelaide hills. The leaves of this variety are also narrower or more lanceolate than those of the typical form, and the whole tree is easily recognisable from its stem and branches being usually covered with a hoary or glaucous substance. North of the position indicated the tree is generally confined to the more elevated and hilly portions of the Colony. The typical form is to be found all along the Mount Lofty chain of hills and the plains from Encounter Bay to north beyond Barossa, while specimens are to be met with on Kangaroo Island. The other species named, commonly known as the black wattle, is chiefly confined to the south-eastern portions of the Colony. The broad-leaved wattle seldom attains a height of more than 25 feet, with a diameter of 8 inches, although in Brown's "Forest Flora" it is stated that a tree

was felled at the Semaphore lately, 35 feet in height and 18 inches in diameter. *Acacia decurrens* grows to a large tree in the South-East, and may there often be met with over 40 feet in height and 2 feet in diameter. The average yield of bark of the broad-leaf may be put down at about 70 lbs. for full, well-grown trees, 7 to 8 years of age; while it is not an uncommon thing to get 500 lbs. from the black wattle of a similar age. Although the *Pycnantha* is a smaller tree than the other, and is generally less rapid in growth, its bulk is of greater commercial value, owing to its yielding a larger percentage of tannic acid than the black. The *Pycnantha* on an average yields about 35 per cent. of tannic acid, sometimes as much as 40 per cent., while the *Acacia decurrens* rarely gives more than 25 per cent. The logical inference therefore points towards *Acacia decurrens* as the most profitable for cultivation, as in spite of the lower yield of tannic acid per ton this disadvantage is fully met by the increased yield per acre. Both trees grow readily in almost any soil, although they seem to have a preference for those of a sandy nature on surface, supported by a good yellow clay subsoil. When grown upon pure sand, the bark is somewhat deficient in tannic acid, being at the same time of a thin nature and too full of sap to pay well for stripping. It is worthy of note that bark stripped from trees which have been grown upon poor stony ground produces the greatest percentage of tannic acid. This is a fact of great importance, as there is an immense area of country in this colony of this nature that has hitherto been classified as unproductive land, but which might with great profit be utilized in the production of these trees.

Both species attain their prime condition between the ages of six and ten years, according to locality and quality of soil. When they are grown on the sandy soil, *i.e.*, with clay bottom, they come in for stripping about the sixth year, while on the stony ground it may safely be asserted that the trees would not mature and pay—"pay" meaning the fullest return obtainable from the tree—to strip before the eighth year. Attention may have been called to the immense amount of pig-face country along our southern coast-line on the one hand, and the numbers of rocky patches scattered over the inland country, both of which are suitable for profitable wattle growing. Touching the methods of cultivation, sandy soil being of a loose nature, the crop should be put in with the plough by ploughing strips 18 inches broad and 4 feet apart to a depth of about 4 inches. The seed should then be dropped in about 3 feet apart along the rows. For the first two years after the crop has been sown the ground betwixt the rows should be regularly ploughed or scarified, for the more the land is stirred the more moisture will find its way to the roots, ensuring quicker growth, while ploughing will at all times prove a very valuable ally against fire. The latter item is worthy of note, for I believe

I am correct in saying, that the various insurance offices do not accept wattle risks although far safer than the wheat crops so readily accepted. By adopting this method of cultivation, it is calculated that at least two years will be saved in the maturing of the plants than if left to Dame Nature. About the second year pruning must be taken in hand. The rows should be taken in hand systematically, and all large lateral branches which may appear to be interfering with the upward growth of the plant should come off. This operation should be repeated during the third year, after which the trees, partly from the effect of this operation and partly by their proximity to one another, will attain that straight upward tendency of growth which must necessarily be regarded as one of the principal features of a successful wattle plantation, because it is only from straight trees that the bark can be removed with facility, and as a natural consequence the price payable for stripping reduced to its lowest ebb. It may be here noted that the bark which produces the greatest percentage of tannic acid is that which grows on the stem of the tree, and therefore the system of cultivation should be directed to produce as large a bulk of stem as possible, with the least amount of lateral growth in the shape of branches as is consistent with the proper health of the trees. This can only be obtained by thick planting in the first instance, and early pruning as above indicated in the second place. From careful experiments made it has been ascertained beyond doubt that at least 25 per cent. more of tannic acid can be procured from a well-pruned tree than from one left to its own devices, involving that branchy growth which is one of the principal characteristics of the tree.

In the method of planting indicated above, planting at a distance of 4 feet apart has been advocated, but I must here state that many authorities, among whom I may mention the Conservator of Forests, advocate planting at a distance of 8 feet apart in the first instance, and filling up between these rows at the end of the third year. Of course, as wattle cultivation is a thing of the future, experience only can decide on what is at present an open question.

On rocky soil, of course, the same method of cultivation cannot be followed that is feasible on that of a sandy nature, and it is necessary to substitute the spade for the plough. This is, of course, assuming the soil to be of a hard nature. If, however, the soil is of a loose nature it will be found sufficient to sow the seed broadcast after a heavy fall of rain, and the success will be all the more assured if a flock of sheep be run over the area four or five times. This plan has been successfully carried out by the Forest Department in the South-East at Mount Burr. The next item of importance is the preparation of seed. When this is intended to be covered, either in ploughed ground or by the spade, the plan of scalding the seed has been found to

answer the purpose admirably. The simplest way of scalding the seed is to pour almost boiling water upon it. The seed should then be left to soak for about forty-eight hours, and afterwards sweated in a damp bag until quite soft. For broadcast sowing on the surface, however, this does not give good results, because the seed being half-germinated a change of the weather to dryness is sure to result in a stoppage in germination, and consequently, from want of moisture, causes the young shoots to "damp-off," and the seed decays. In order to obviate this, and prepare the seed all ready for germination in such a manner that it will be independent of any sort of weather, the plan has been adopted of cracking the outer hard covering of the seed by the means of slow firing without partial germination, so that the seed can be sown upon the ground, and lie there without injury until sufficient rain falls to make it germinate. In this manner the seed can be sown two or three months before winter, and thus will be in readiness to benefit by the first rains of the season, and consequently the young plants will, before the rainy season is over, have attained such a hold upon the ground that their safety is secured during the following dry season. An explanation of the system adopted will be *apropos*. A high heap of wood is formed and fired; when this has smouldered down to a common expiring condition of red coals and ashes, the seed is thrown into the heap, and the whole stirred up and allowed to remain until the fire goes out. The embers are then raked in a heap, and the ashes and seed bagged together ready for sowing broadcast. There is no doubt that this system is only following out what we see in nature, as all colonists have no doubt noticed that when branches or débris of a wattle-tree have been burned numerous young trees spring up as a matter of course. Following out this system, it is only necessary when indigenous wattle plantations are conserved to burn up the branches of the trees which have been stripped in order to secure a luxuriant young crop. This method has been successfully carried out at the Mount Brown Forest Reserve.

From recent analyses it appears that although the bark upon the trunk of the tree produces the largest percentage of tannic acid, that upon the branches and twigs, as well as the leaves themselves, and to a certain extent the wood of the tree, contain a fair percentage of tannin. In some cases a greater percentage of tannic acid was obtained from the twigs and branches than is procurable from the best English oak bark (which, by the way, is very difficult to strip). This fact opens a question. Cannot we utilize the tannic acid which, under the present system, is allowed to go to waste on the ground? It is well known to all colonists that hitherto strippers of this bark seldom or never attempt to remove it from the branches, and it has been calculated that in consequence of this, of every one which has been or is being stripped at least one-third of its tannic

acid has been allowed to go to waste. Looking at this fact then and also bearing in mind that however well the trees may be cultivated and pruned under the system recommended, there must always be a considerable quantity of branches and leaves, it is thought that when the wattle is cultivated as a commercial crop some means should be adopted whereby the tannic acid in this débris could be utilized, and the idea has been broached that this might be effected by a boiling-down system.* Huge tanks could be constructed, into which every portion of the tree could be placed after being chopped up, and the tannic acid extracted. The plan seems feasible enough, and if it can be profitably carried out as suggested, possibly it could be improved on so as to place the tree in whole without any chopping whatever. Enormous saving from its adoption must necessarily ensue; less cost than stripping, in the first place; considerable economy in carting to market; less bulk for export; no loss from pruning. In addition to these advantages the pap would eventually come in either for paper-making or manure. As, however, this plan has not yet been adopted, I cannot submit figures in a balance-sheet. Before submitting an estimate on the probable results of wattle cultivation as an industry, I would like to refer to two pamphlets on the subject already in print. One of these is termed "Wattle Bark," and is substantially a report of the Board of Enquiry appointed in Victoria; the other is termed "Wattle Farming," and is written by Dr. Schomburgk, and published by the Chamber of Manufactures. The former is devoted almost entirely to the rise and progress of the wattle-bark trade of Victoria, and the evidence of some two hundred witnesses who were examined. Into this I will not dip, but an appendix to the work gives a statement showing the profit to be derived from the systematic cultivation of wattles compiled as a result of the enquiries instituted, which deserves attention. I do not for a moment wish to damp the enthusiasm of advocates of wattle cultivation, but I would point out:—

1. That if the production of wattle-bark varies between two given numbers per acre it is safer in estimating to take the lowest and thus be prepared for casualty.

2. That although there is every reason to believe that "cultivated" wattles could be stripped for at least half the amount paid for stripping those which have been left to nature, still there is reason to doubt whether strippers at the present time make really good wages at the work, and the reduction that would ensue is, therefore, problematical.

The Wattle Commission and Dr. Schomburgk show a profit of over £2,000 per 100 acres in a run of eight years, and arrive at this highly desirable conclusion by estimating a return of 1,213 tons of bark from those 100 acres. On the other hand

* The system adopted in India of boiling down pieces of *A. Catechu* for Kutch might possibly be adopted.—[ED.]

stripping is estimated at 15*s.* per ton as against 30*s.* now actually paid in this Colony, while cartage is put down at 10*s.* per ton, which, at the present price of wages, I consider, with all due deference, to be at least 30 per cent. below the probable expenditure.

As selectors in this Colony are permitted to take up 1,000 acres, I have chosen that area for my calculations, and this, according to the Wattle Commission, would yield over 12,000 tons, whereas I put it down at 5,000 so as to be on the safe side. With regard to pruning, the Commission estimate 10*s.* per acre as against my 4*s.*, and this is the only item in which my figures come under those of the Commission and Dr. Schomburgk. I am of opinion that the item *might* be left out entirely, as the Manager would almost as a matter of course take this into his own hands, and his salary is scheduled. Attention is called to the following facts :—

1. The bark from the broad-leaved wattle is the best in the world ; that from the black wattle the second best.
2. The price of bark is rising, and good material is so scarce that a quantity of inferior bark is used by European tanners out of sheer necessity.
3. Land that will grow wattles successfully is not at present looked upon as worth £4 per acre, the amount set down in the following estimate :—

Estimate of expenditure on a Wattle plantation of 1,000 *acres valued at £4,000 for six years.*

	£
Interest on freehold, + compound thereon, ...	2,150
Ploughing and sowing, at 10*s.* per acre, + interest, ..	835
Pruning second and third years, at 4*s.* per acre, for the two years, + interest, ...	291
Scarifying twice, + interest, say, ...	500
Unforeseen expenses, say,..	100
Cartage to market and stripping, at £1 and £1 10*s.* respectively, ...	12,500
Supervision, ...	860
Balance of profit over and above good commercial return for capital throughout, ...	7,764
Total, ...	25,000

Receipts.

Sale of 5,000 tons bark, at £5, ...	25,000

It will be seen that no credit has been taken for the gum procurable from the plantation, nor for seed. Again, the price of bark has been set down at £5, while it is being sold for considerably over £7 at the present time, and in six years' time must fetch more. There were sales in London of chopped bark at £17 per ton recently. Some believers in wattle-growing advocate sheep being run over the plantations after the first two years, but there are two objections to this, *viz.*, if the ground be thoroughly planted there will be very little grass, and that of an

inferior character; and secondly, this plan would interfere with the natural regeneration, involving re-sowing and consequent delay. If the plantation be devoted to wattles, and wattles only, a crop may be relied on every third year after the first six. Yet another point to be remembered. The galls growing on the trees are of considerable value, and could be most profitably utilized on large plantations.

Note.—The above article has been read by me, and I can confidently endorse the general remarks, while I consider that the probable profits shown in the balance-sheet are in no way over-estimated.—J. E. Brown, *Conservator of Forests.*

REPORT ON BEES.

By a CHITTAGONG FORESTER.*

THERE are six races of bees found in the forests bordering of the river Eadgong. When the time of spring came and the flowers are abundently open in the trees and plants of various kind of the forests, they are taught by nature to make a temporal havitation or hive for multiplying their races. Among those six races, three are larger in figure possessed of long sting, six legs, two whiskers, two wings, and of four or five trunks in the mouth, and by which they can collect the particles from the open flowers. Their races can be easily distinguished by their colours ; some are black, some red, others purple. But lower part of the body of each race seems something yellowish. The black and purple coloured races are seemed to be milder than that of red, whom in these villages designate a fiery race, observing their fury to those who came to plunder their stores.

Being curious to look out the hive, I had, on a day, through the melody of wild birds and the continual singing of wild creeping shells, taken a happy tour to the forests, not far from my station, with some prudent villager, whose end was so as mine, and saw one in the branch of a large tree, situated on the bank of a small lake hanging like a large triangular figure bending its head towards the ground. The bees were crowded over the surface of the hive, and appeared from a distant as thousand eyes were open to gaze and watch over the robbers of their stores. They were very hurry on their works—some going to and others coming from the lake ; and some went very distant region. At these signs, my companions showed me two augmented parts of the hive, which they called shoulders ; and informed me, that honey was riped there. I inquired them how could they know that ? They answered me—" that the labours of the bees for collecting flowery particles have been now over ;

* Sent in reply to certain enquiries circulated by Mr. Douglas, author of a treatise on Indian bees.—[ED.]

REPORT ON BEES.

Fig. 1.

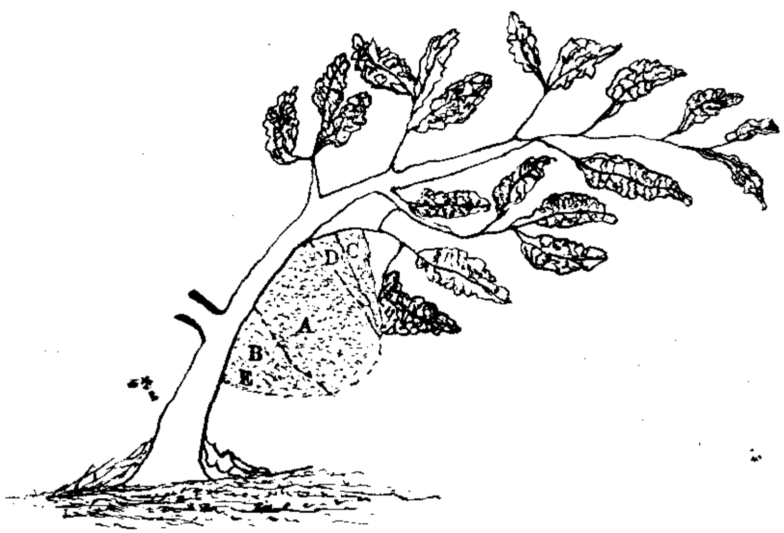
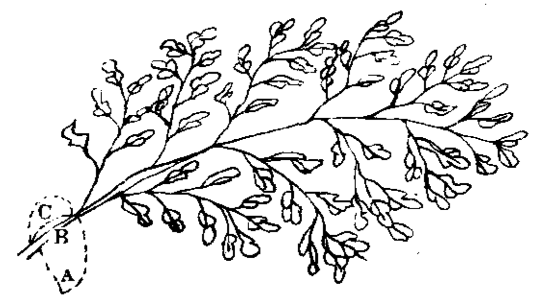


Fig. 2.



Litho. T. C. Press, Roorkee.

THOS. D. BONA, Supdt.

and that for watery and excremental are now going on. Because the honey is a fluid, made with those three substances (*i.e.*, particles of flowers, water, and excrement of men and cattle) by the wonderful "chymical works of nature." I was surprised at this intelligence, thinking that the thing so belong to the taste of human being and of our dieties are originally a part of so abominated a thing as excrement. I thought it possible recollecting the case of sulphur and quick-silver being cohered make up different thing quite different in properties of their origins.

Having sunk into deep thought, I walked few steps ; and found in a place two other hives, plundered by wild bears ; and the poor bees were collected in masses in several branches of the trees, as they were very sorry for their youngs as for their stores.

For fear to be robbed by an wild bear, I ordered my companions to cut the shoulders or honey parts from the hive, which we have seen before and which was still unspoiled ; and then returned to my station. At that very night, my companions brought before me the whole hive. I inquired them—"why they have done so"? They told me, that they destroyed the youngs by cutting their hive and also burned half the bees only for revenging them, who annoyed them much by their stings, and failed their all exertion to drive them from it. I was very sorry, observing such a cruelty done by companions, saying that the bees, being the resident of the forests are subjects to our Forest Department ; and that matter will be reported to prosecute a criminal suit against them, according to the section 425 of the Indian Penal Code for enquiring the sources of common interest. They tried to overcome me by their reasons, remonstrating that many thousand sources of common interest are daily entered in the bellies of Jumias and other Mugh people. Why then I not reported against them? I answered them, that I did not find a prove of their doing so. Now they were very hurry to satisfy me by their solicitation and promised me that they will neither burn the bees nor cut their whole hive any more.

Then I began to examine the hive ; and was surprised with sentiment and regularities which these wonderful insects have displayed in it, surpassing all the art of the human artisan. It has two sides or surfaces ; each consisting of innumerable cells, having a bottom, a plat of wax like thin paper which has been spread in the middle from up to end as a foundation of its construction. Each cells contain six equal sides, made of some substance in similar manner, and covered with the plat of which coloured wax, wherein the poor posterities of the bees have been laid ; some like eggs, some moving worms, and others with all the limbers similar to their ancestors.

In the figure No. 1, I wish to represent a resemblance of bee-hive, that I have seen before when it was hanging on a tree.

The youngs are living at the part A, in the wombs of numer-

ous cells in aforesaid manner; the honey at B in the combs covered with waxen plat and sealed thereon as men do on their covers; and the flowery particles at C, in the open cells, which are called "Fóól Sírá (*i.e.*, abodes of the flowery atoms) which will be shut up afterwards and be added with B or honey part, when they turned into fluid.

I have a got a very curious intelligence from a villager, whose business was at leasure to search bee-hive, that by sweet scents of the honey and flowery particles animate the eggs and nurse them, till they are by nature transformed into worms and worms into bees. But I think, the eggs are endowed with all things by which they can themselves be animated, nursed and frairned into worms and worms into bees, and then hibing all the organs necessary to support their lives, they issue from the cells, and begin to drink honey.

I was moreover told, that when the present generation of youngs releasis the cells, the eggs for another will be laid therein; and those will be also succeeded by third generation. At last, the whole hive will be filled with honey. Then having sufficient strength by eating all the stores, they fly with their parent, leaving the vacant hive hanging on the tree.

The hives which have one shoulder are found generally in everywhere; but those which have two are very rare.

Sometimes, it occurs, that many hives are made in the trees nearer to each other. The men, who search honey, sacrifice a cow or a goat under those trees in name of their *Allah*, begging His grace as to enclose the fury of the insects. They are called Hazarií-Bússú or the collection of many hives.

After producing their youngs, the bees do not live in fixed place. They go everywhere, they see their subsistances. Sometime, they live in a place for fortnight together, and at all time, it appears as a hive is made. Some years ago, my uncle once told me, that he saw a very big hive in our village. As I was a very curious boy and fond of such an enterprise as to break bee-hive went with him. When my uncle evaporated a grass candle below it, all the bees hummingly fled away, leaving nothing else in the tree. Then my uncle told me with a joke, "that you are a very unfortunate boy; and finding you very eager to lick up honey, the hive is turned into vacuam. From that time I call that kind of hive is a "cheating hive" or "resting bees."

To cut honey-part from the hives is a work, by which men take voluntarily lives in a point of destruction. Sometimes, they are obliged to ascend upon a very high tree. If the bees be a milder race, they fly on; when get a scent of steams, evaporated by cutters below the hives; and if a fiery race, it is very seldom to descend without having some of their stings. Three years ago three villagers of Endghur were killed by the stings of those furious insects—two falling from the trees, and other after three days of unremitted fever.

Now I wish to narrate another three races, which are commonly called flies; because they have no stings; and their sizes, their manners, and their construction of hives are different from those of bees. One larger race, at spring time, makes a small temporal hive on the bough of a tree; the resemblance of which I am desplaying in the figure No. 2.

The cells at the part A are filled with the youngs; those at B, the honey; those at C, the flowery particles, according to the manner I mentioned before in the narration of bees. At this kind of a hive, the honey is found not more than one seer, when that at bees, sometimes it measured 15 or 20 seers.

One day, some boys whispered to my ears, that they saw a flying hive in the woods; and at that very moment, I went with them to look it out. But the naughty boys, neglecting that I denied them not to exite their rages, cut the bough on which it was built, and then they all fled away. Having a fatty constitution, without sufficient strength to carry it swiftly as the boys, I could not fly with them.

The wicked flies, finding no other at present, and anticipating that I was cause and abettor of their harm, fell on me, pulled my hairs and skins, and annoyed me so much that at last, finding no other means, I jumped into the river; and yet I saw, they were humming over my head. Fortunately they had no sting and then I was secured. After a few moment, I saw, that said boys were coming with a shoulder or honey part. I called them; and took my just share pinching it before me. It was very dense, but not so white as honey, found in the bee-hives. Its color appeared something yellowish.

Among two other races, the bigger one constructs a subteraneous hive round as uneven porous ball, divided into several corners, where their youngs are living. In the hole, where the hive is made, they also make 14 or 15 waxen balls, called Fynugs, in which their honey is stored. By pinching those balls, the honey is found not more than two seers. They make a convex passage plastered with wax, by which they can enter to and return from their hive. I have not seen their hive, so I cannot describe more than these.

Another race is very small in their sizes. They make a hive (I was told) in aforesaid manner; and only difference is that, it is made in the hole of a tree. In the Fynugs of this race, the honey is found not more than one seer. It is very dense, but not so good to taste as that found in the bee-hive.

The abodes of above two races, who make Fynugs in the holes (I was told) are not temporal. They live in a place for three or four years together; although it appears, they make honey and produce their youngs at spring time.

Now I proceed to answer plainly all the questions, requested by Mr. Doglace in the following clauses:—

1st Answer.—From the forests of Eadgong the honey is not

collected equally in every years. In some years it is supposed nearly 30 maunds, and in other, not more than 10 or 20 maunds. I was told that, if the bees are not injured by Jumias and Mughs, it may be exported nearly 50 or 60 maunds in a year. It is not come by the way to river, and carried by shoulder to the market of Eadgong and sold there, by the villagers of Eadghur, Eadgong and Bhomaria Ghonah, who, I think, by this liquid may earn 400 or 500 Rupees yearly. A few seers are remaining here for the use of the inhabitants, and other is exported to several villages in this District.

2nd Answer—No.

I called some villagers and requested them whether the bees may be collected to put them into tamed state or not. They were surprised at this question, and answered me, "that it is quite impossible. Because, the Allah hast given them a vast region of forests to live in, and to rove from flowers to flowers. How can they be collected to tame them in a habitation of men? I remonstrated at this question, stating that the elephant is a beast with habit of living almost in a wild state. How he is brought from the forests and obeys the orders of human being? At this question they were quite unanswered. But I think, it is not an easiest thing, by enclosing their roving character, to practise them to obey our commands. Because, they are so little animals and possessed of so little senses that they are remained up to this day, quite out of our jurisdiction. If we apply any corporal punishment to them as we do to revoltous beasts and birds to obey us, then, they will surely die; or will be out of detainging themselves their lives. If there is a man to plant a vast grove, where the flowers are open twelve months together, then he, spreading an iron net over it, may put some hundred of bees into confinement. But I cannot assure, at this circumstance, whether the hives they make or not; and if make and produce their youngs they will be maintained sufficiently or not without enlargement of the grove.

3rd Answer.—If it be possible to tame bees, then, I think, by former three races, which I have described in my above narrations, the men must earn more honey than that of other three races.

By my above narration, I hope, Mr. Doglace will be pleased to compare the bees, found in our country with those in Europe or in the frigid zone. I can not compare them, because I am quite unknown of the races, found in those cold countries.

IV. Notes, Queries and Extracts.

THE ASIATIC ELEPHANT IN FREEDOM AND CAPTIVITY.

(*Continued from page 539*).

THIS quotation from Sir Emerson Tennent shows the similarity of opinion between the natives of Ceylon and of India. But the belief of a universal sepulchre is untenable on many grounds. It may be believed that, in annually capturing large numbers of elephants, the hunters of the Dacca establishment penetrate the most retired parts of the jungles of Assam, Chittagong, and elsewhere; but though many men have grown grey in the service, I have not met one who has seen a dead elephant's remains, except at a time when an epidemic disease decimated the herds in Chittagong. Jungle fires seldom penetrate the large forests; thus their bones cannot be burned. Monsoon rains do not destroy them for some years, as is proved by the bones of elephants that have been shot, and which may be seen many years later. It may be thought that aged, weak elephants are sometimes unable to extricate themselves from morasses or the soft beds of rivers where they go to take their last drink, and that their remains are swallowed up therein. This possibly may occur occasionally, but there are many elephant jungles where no quicksands or bogs exist. In Mysore, for instance, a province where wild elephants abound, and which I know intimately, the jungle streams are small, and their beds are uniformly rocky. If elephants died in these, their bodies would be floated down through inhabited country where they could not escape observation. But this has never, to my knowledge, occurred. It is probable that the longevity of elephants may account to a great extent for their remains rarely being seen. If elephants live for 200 years, the annual deaths from natural causes would only amount to 5 per 1,000. This figure would, no doubt, be exceeded in reality, as elephants are liable to be killed by each other, and to die by various accidents. Though the number that annually die is thus, probably, much less than might be supposed, the mystery of what becomes of their remains is still entirely unexplained.

Herds of elephants usually consist of from 30 to 50 individuals, but much larger numbers, even upwards of 100, are by no means uncommon. A herd is always led by a female, never by

a male. In localities where fodder is scarce, a large herd usually divides into parties of from 10 to 20. These remain at some little distance from each other, but all take part in any common movement, such as a march into another tract of forest. These separate parties are family groups, consisting of old elephants with their children and grand-children. It thus happens that, though the gregarious instincts of elephants prompt them to form large gatherings, if circumstances necessitate it, a herd breaks up under several leaders. Cases frequently occur when they are being hunted; each party will then take measures for its individual safety. It cannot be said that a large herd has any supreme leader. Tuskers never interest themselves in the movement of their herds; they wander much alone, either to visit cultivation where the females, encumbered with young ones, hesitate to follow, or from a love of solitude. Single elephants found wandering in the forests are usually young males, animals debarred from much intimate association with the herds, by stronger rivals; but they usually keep within a few miles of their companions. These wandering tuskers are only biding their time until they are able to meet all comers in a herd. The necessity for the females regulating the movements of a herd is evident, as they must accomodate the length and time of their marches, and the localities in which they rest and feed at different hours, to the requirements of their young ones.

Elephant calves usually stand exactly 36 inches at the shoulder, when born, and weigh about 200 lbs. They live entirely upon milk for five or six months, when they begin to eat tender grass. Their chief support, however, is still milk for some months. I have known three cases of elephants having two calves at a birth. It cannot be said that the female elephant evinces any special attachment to her offspring, whilst the belief that all the females of a herd show affection for each other's calves is certainly erroneous; were such the case, it would preclude the belief in any marked love for her own young. During the catching of elephants many cases occur in which young ones, after losing their mothers by death or separation, are refused assistance by the other females, and are buffeted about as outcasts. When a calf is born, the mother and the herd usually remain in that place for two days. The calf is then capable of marching. Even at this tender age, calves are no encumbrance to the herd's movement; the youngest climb hills, and cross rivers, assisted by their dams. In swimming, very young calves are supported by their mother's trunks, and are held in front of them. When they are a few months old, they scramble on to their mother's shoulders, and hold on with their forelegs, or they swim alone. Though a few calves are born at other seasons, the largest number make their appearance in September, October, and November.

The elephant is full grown, but is not fully mature, at about

25 years of age. At this period it may be compared to a human being of 18, and it does not attain its full strength and vigour before 35 years. Female elephants give birth to their first calf at from 13 to 16 years of age, when they are still palpably immature themselves. Only the male Indian elephant has tusks; the female is provided with short tushes, or downward prongs, in the upper jaw; they are seldom more than 4 inches in length. On the continent of India, *makhnas*, or male elephants without tusks, are decidedly rare. The absence of tusks appears to be a merely accidental circumstance. But in Ceylon, male elephants with tusks are still more uncommon. Sir Samuel Baker says that not more than one in 300 is provided with them. It is difficult to imagine what can cause the vital difference of tusks and no tusks between the elephants of the continent and of Ceylon, as they are of the same species, and the climate and their food may be said to be identical. Elephants occasionally lose one, sometimes both tusks, in accidents in the jungle, and some have only one tusk from birth. The latter are known as *ganéshas*, and are reverenced by Hindus if the tusk retained be the right hand one. Elephants never shed their tusks. Jerdon and others, following Mr. Corse, are undoubtedly in error in saying this occurs between the first and second years of the young elephant's existence, or at any other time. The skulls of fœtal elephants exhibit milk tusks, but these never make their appearance; they are absorbed, and the tusk that cuts the gum is the permanent one. Nor are tusks lost by accident ever renewed.

The records of many hundreds of elephants, captured by the Dacca establishment, show that there are about 43 male elephants to 100 females; and one *makhna*, or tuskless male, in every 10 males.

Elephants are exceedingly inoffensive and retiring in their habits. In their wild state they are very timid, and withdraw at once from the intrusion of man. They usually drink after sunrise and before sunset. They prefer the water of the small tributary streams to that of the larger rivers of the jungles they are inhabiting; for what reason I have never been able to ascertain. Elephants seldom bathe after the sun is down, except in very warm weather. They swim remarkably well, as is proved by the fact that large numbers are annually sent across the tideway of the combined Ganges and Brahmapútra, between Dacca and Barrackpore, and they are sometimes six consecutive hours without touching bottom. I have seen an elephant swim a river 300 yards wide with his hind legs tied together. Elephants are sometimes drowned, apparently by being attacked with cramp or by a fit.

The only pace of the elephant is the walk, capable of being increased to a fast shuffle of about fifteen miles an hour, for a very short distance. The elephant can neither trot, canter, or gallop, nor can it make the smallest spring either in vertical

height or in horizontal distance. A trench 8 feet wide and 8 feet deep is quite impassable to an elephant.

It has been satisfactorily settled that there is no such creature as a really white elephant, the so-called albinoes of the Kings of Burmah and Siam being merely elephants of a somewhat dirty cream colour, and in some cases even elephants with only an unusual amount of the flesh-coloured blotchings on the face, ears, and neck, common in some degree to all elephants. I need not advert here to Mr. Barnum's so-called white elephant further than to say that he is the commonest of common elephants, to be seen every day in India, and does not possess a single peculiarity of any description to justify the statements regarding his colour and special character, which preceded and even followed his arrival in England.

I will now pass to the modes of capturing and training the elephant. Elephants are not bred in captivity in India, as by the time the young ones would be of a useful age, 15 years, they would have cost more than would suffice to capture a number of mature wild ones. Elephants are, however, bred extensively in a semi-wild state in Burmah and in Siam, where fodder is very plentiful. With the exception of such elephants as come from Burmah, almost every elephant seen in India has been wild at one time.

The following are the methods of taking wild elephants. For single elephants, pit-falls; running down and noosing from trained elephants' backs; or tying the animal's legs together under cover of trained females, usually called decoys. When a whole herd is the object of pursuit, a salt-lick, or sometimes a pool in the jungles, is surrounded by a stockade. Men are constantly on the watch, and the gate is closed when a herd has entered. But the most certain plan is that followed by Government, namely, the surrounding a herd, wherever found in the forest, by a large circle of men, and the building a stockade, into which it is driven. This method will be described further on. With regard to the other plans mentioned, the pit-fall is an old native method, and is now prohibited in British territory on account of its cruelty. It may be imagined that an immense majority of the elephants that fell into pits from 15 to 18 feet deep sustained permanent injury, if they were not killed outright, as often happened. The native hunters seldom took the trouble to put boughs into the pits to break the force of an elephant's fall. If an elephant was seen to be injured, it was left to die as it fell. I have known four elephants to fall into the same pit together, one only of which was got out alive.

The pits were arranged with great ingenuity by the hunters. Sometimes an uncovered one would be left in view, in avoiding which an elephant fell into a covered one alongside. Or several were dug in close proximity, in which others might be taken when fleeing in terror upon the fall of one of their number.

Through the carelessness of the hunters, who only visited the pits occasionally, elephants were frequently starved to death before they were discovered.

The plan of enclosing elephants in salt-licks, or places to which elephants, in common with all wild elephants, resort at certain seasons to eat the earth impregnated with soda,* used formerly to be much in vogue in Assam. It also led to much cruelty. Natives could seldom procure a sufficient number of tame elephants to deal with a large herd, should one be enclosed; and in former days, scores of elephants died in enclosures from want of food, during the delay that occurred in sending for tame elephants. Several of these salt-licks are perfect Golgothas to this day. Such reckless waste of elephant life has now, however, been put a stop to.

Running elephants down, and noosing them from the backs of tame elephants is very rough and dangerous, but highly exciting, sport. It is far from an economical method of taking them, as the wear and tear of the tame elephants is very great. It is conducted as follows :—Three or four fast tame elephants are equipped with a rope each, at one end of which there is a noose, the other being secured round their bodies. On some, the noose is on the near side, on others, the off. Each elephant has three riders—the mahout on its neck to guide it; the nooser, kneeling on a small pad on its back, holding the noose in his hands; and a spare man seated behind, whose duty it is to hammer it unmercifully with a spiked mallet. This urges an elephant to a much greater pace than any use of the driver's goad, though that inducement is by no means omitted.

Thus equipped, the elephants approach a herd of wild ones. Sometimes a musket is fired to terrify them, and the chase commences through or over everything, the men saving themselves from being swept off as best they can. Where the ground is favourable, the tame elephants endeavour to range up on opposite sides of a fleeing wild one, of moderate size and strength, when the nooses are cast, and generally encircle its neck. If this is effected, the tame elephants are checked; but the choking of the wild one or fatal accidents to the tame ones or their riders by being pulled over, or dragged into ravines, or by being attacked by other elephants, are not unusual accompaniments to this rough work.

Hand-noosing is practised only in Ceylon, where several hunters on foot manage, with wonderful skill and activity, to noose the hind legs of an elephant when running away, and to secure the trailing ends of the ropes to trees as it passes.

The largest male elephants cannot be captured by the above plans; and from their habit of frequently absenting themselves from their companions, they are seldom caught with the herd by the stockade or kheddah plan. They are the most valuable

* Or potash ?—[ED.]

beasts, and are easily caught in the following manner, or some modification of it. Four or five steady females, ridden by their mahouts, who partly conceal themselves with a dark-coloured blanket as they lie on their elephants' necks, are taken to the jungle where the solitary male is known to be, and are there allowed to graze like wild ones, and gradually to approach the male, if he does not take the initiative. Some wild males make off at once, probably scenting the riders, but many abandon themselves without reserve to the society of the females. These keep in constant attendance on the male, sometimes for two days and nights. When the male seems inclined to sleep soundly, usually soon after sunrise, the females stand close around him, and a couple of mahouts on foot tie his hind legs together, and bind him to a tree if one be near ; or they withdraw the tame elephants, and after the male has tired himself out, by dragging his legs after him in his flight, he is fastened to some tree as he passes it. In a day or two cables are got round his neck, and he is marched off.

I may here say that the term decoy, often used in reference to elephants engaged in the capture of others, is entirely misleading, as they use no arts to divert the wild one's attention, as has been constantly asserted, but act entirely at the command of their riders. The statement that one elephant will assist in binding another, except in as far as it will hand up the end of a rope, or pull one when ordered to do so, is entirely incorrect.

The Government kheddah plan is the most certain and economical method of taking wild elephants. As many as 118 have been secured in one drive by this means. A Government hunting party consists of 370 men trained to the work. They are generally from Chittagong, the natives of that district being unrivalled in the craft. There is a large surplus labouring population in Chittagong, and there is no difficulty in raising one or two kheddah parties during December, January, and February, when there are no agricultural operations on hand. The men receive two-and-a-half months' pay at Rs. 7 (or about 15*s.*) per mensem, and they also have free rations.

A kheddah party of 370 men having been collected, it marches to the hunting grounds, sometimes 200 miles distant, where a base camp is ready, and where the establishment of tame elephants, generally from 100 to 150, has been collected, together with the stores, tools, and ropes required for the operations. Muskets and rations having been delivered to the men, and religious ceremonies for success having been performed, the hunters enter the jungle. The trackers of the party have probably already marked down a herd, whereupon the hunters approach to within a mile, and then divide under two experienced leaders, one-half filing off to the right, and the other to the left, their object being to enclose the herd in a large circle by meeting beyond it. A man is left at every 30 yards or so along the

lines, according to the nature of the ground. The skill with which this movement is effected is very remarkable, as the ground is usually quite unknown to the hunters, and the difficulty of crossing streams and hills, of forcing their way through dense jungle where no path exists, and of gaining the point they are making for without a compass, is considerable.

The circle, when completed, is often five or six miles in circumference. A large one, with men posted fifty yards apart or so, is more efficient in keeping in a herd than a smaller one with men much closer. Unless plenty of room be allowed to the elephants, they are liable to break through the cordon of guards; but it is a maxim in elephant catching that, the circle having once been formed, a herd can only escape through accident or great carelessness. It usually takes three or four hours to surround elephants. In a couple of hours the hunters run up a thin fence of split bamboos round the enclosure, and clear a path for communication between each others posts. Their chief duty then is to see that the elephants do not break out of the circle. The animals seldom give trouble during the day; at night large fires are kept up, and shouts and shots are used to drive them back should they approach. The bamboo fencing serves to show the chief hunters, who patrol the circle at intervals, where the elephants have broken out should they escape, so that the particular men who are to blame can be detected. This investment of the elephants may have to be maintained for a week, sometimes for a month, if the elephants cannot be secured in the first attempts.

(To be continued).

ANTISEPTIC TREATMENT OF TIMBER.—This is a subject of perhaps greater interest to those connected with mining than with any other industry. The paper of Mr. S. B. Boulton, read before the Institute of Civil Engineers (the President, Sir. J. W. Bazalgette, C.B., in the chair) will be generally acceptable. The author commenced by referring to a paper by his late partner, M. H. P. Burt, Assoc. Inst. C.E., on the subject of Timber-Preserving, which had been read at the Institution in 1853. Since that date the use of antiseptics for the treatment of timber had greatly increased. The process called creosoting, or the employment of the heavy oils of coal tar, had almost entirely displaced the other methods, whilst the manufactures connected with the residual products of gas-making, from one of which residuals the creosote oils were derived, had experienced an enormous development. The author's connection, during 34 years, with this group of industries, enabled him to offer the results of some personal experience and research, which he presented, together with those arrived at by other investigators.

An historical description of the antiseptic treatment of timber

was preceded by a few notes on the methods pursued by the ancients for the preservation of wood and other perishable materials. The ancients were well acquainted with the manufacture and use of many kinds of oils, tars, and bitumens, and frequently used them for the preparation of wood, with respect to which some notable instances were cited. The methods employed by the Egyptians in embalming their dead were dwelt upon at some length, and the author endeavoured to elucidate some discrepancies in the descriptions of these processes, as recorded by Herodotus and Diodorus Siculus. The researches of Pettigrew were alluded to, particularly his interesting experiment upon the heart of a mummy, which, after 3000 years' preservation, began immediately to putrify, when the antiseptic substances were removed by maceration. This appeared to prove that no chemical transformation had taken place, but that the long immunity from decay had been the result of the abiding presence of the antiseptic.

The growth of theories upon the causes of putrefaction was traced down to the commencement of the present century, reference being made to the "Phlogiston," and other exploded theories; also to the opinions of Macbride, Sir John Pringle, Sir Humphrey Davy, Thomas Wade, and others, and to their suggestions upon timber preserving. The progress of timber preserving during the railway era, and particularly between the years 1838 and 1853, was described with especial reference to the competition between the four most successful of the processes. These four consisted in the employment of corrosive sublimate, sulphate of copper, chloride of zinc, and heavy oil of coal tar, which had been patented in England respectively by Mr. J. H. Kyan, Mr. J. J. Lloyd Margary, Sir William Burnett, and Mr. John Bethell.

The distinction was pointed out between the real creosote, a product derived from the distillation of wood, but which had never been employed for injecting timber, and the so-called creosote which had been so successfully used for that purpose, the latter being a heavy oil produced from distillation of gas-tar. The theory that certain antiseptics preserved timber by coagulating the albumen, and by forming insoluble combinations with the woody fibre, had been advanced on behalf of all the four processes alluded to. But in spite of some acknowledged success, the Kyanizing, Margaryzing, and Burnettizing systems were not found to be so durable in their effects as creosoting. Indeed the salts of metals were gradually washed out of timber exposed to the action of water. On the other hand the success of the creosoting process became completely established.

In order to show the process of manufacture of the creosote oils, a short description was given of the ordinary methods of tar distilling. Coal tar, a black viscous substance, was a residual product of gas making. It was split up by a preliminary process of distillation into three groups of substances—namely :—

1°. Oils lighter than water, containing the naphthas, benzoles, toluols, and other bodies, from some of which the aniline dyes were manufactured. This series of oils had never been used for timber-preserving.

2°. Oils heavier than water ; the dead oils or creosote oils of the timber-yards. These oils contained a great variety of different bodies, the properties of some of which were described, including carbolic acid, cresylic acid, napthalene, anthracene, crysene, pyrene, quinolene, leucoline, acridine, cryptidine, &c.

3°. Pitch, the residium of the distillation.

The creosote oils varied in their characteristics in different districts, according to the nature of the coal used in the gas-works, and to the varying temperatures at which the coal was carbonised. The type of creosote called "London oil," made from the tars derived from the coal of the Newcastle district, was contrasted with the so-called "country oil," typical of the product from the tar of the Midland and other coals. The former contained less of the carbolic and cresylic acids than the latter, but more of the semisolid substance, which solidified within the pores of the timber, and more of the antiseptics which did not volatise except at exceedingly elevated temperatures. The history of the controversy as to the respective merits of the two types of creosote oils was fully gone into. The carbolic and cresylic acids had been recognised as potent antiseptics ; their presence appeared to arrest the action of all destructive germs, and the lighter and thinner country oils, which contained a comparatively large percentage of these tar-acids had, therefore, been preferred by many. The opinion of Dr. Letheby to that effect was recorded. On the other hand, were cited the opinions and practice of the introducers of creosoting, and of the earlier operators in that process, who used in preference the heavier types of creosote ; and the early success of that creosote, both in England and in tropical countries, appeared to confirm their judgment. A number of experiments were then alluded to, stretching over long series of years, and conducted by investigators in this and in other countries for the purpose of ascertaining which of the component portions of the creosote were the most durable and efficient agents in preserving timber. The results of these experiments appeared to show that it was not to the tar acids, but to the heavier and least volatile portions of the creosote, and to those bodies which solidified within the pores of the timber, that the most durable results should be attributed. This apparent anomaly was explained by reference to numerous eminent authorities upon carbolic acid, who, whilst extolling its action as a most useful and powerful antiseptic for sanitary and surgical purposes, were in general agreement as to its possessing the following characteristics :— That it was exceedingly volatile at ordinary temperatures, that it

was readily soluble in water, and its combinations with the other bodies, including albumen, were not stable. It would readily evaporate from timber exposed to the heat of the sun, especially in warm climates, and it would be washed out of timber in contact with water. The author's personal experience and experiments fully bore out the conclusion, that the use of the heavier and less volatile portions of the creosote oils should be encouraged, and that from them the most durable results might be expected. Moreover, it was pointed out that recent investigators have discovered in these heavier oils bodies which, if perhaps less potent, were more durable in their antiseptic effects than carbolic acid. By judicious selection and admixture both London and country oils can be usefully employed. Shale oil and bone oil, however, and other oils lighter than water, should be excluded.

The modern-germ theory was discussed in its relation to timber-preserving, and was believed by the author to be a more practical explanation of the action of antiseptics upon wood than the older theories, as to the coagulation of albumen, and the formation of insoluble compounds. With respect to all bodies which have been extensively used for timber-preserving, their durable results appeared to be in an inverse ratio to their volatility in the atmosphere and their solubility in water. The germ-theory constituted a severe but salutary test in choosing antiseptics for the treatment of wood. In the author's opinion the substances preferred should be not only germicides but germ-excluders; those being the best which were least soluble in water, least volatile in air, and most capable of becoming solid within the pores of the timber.

A description followed of the various kinds of apparatus which had been in use during the present century for injecting timber with antiseptic liquids. The paper concluded with some remarks upon the subject of the hygrometric condition of timber at the time of injection, failures having repeatedly arisen owing to the timber being too wet at the time of creosoting. The author dwelt upon the importance of this subject, describing also his experience with various methods of getting rid of superfluous moisture artificially, and of a process which he had recently inaugurated, by which this result could be obtained in the creosoting cylinder itself without injury to the timber.

The paper was illustrated by diagrams showing the most important products derived from coal, and the apparatus for coal-tar distillation and timber-preserving; also, by tables, giving the properties of coal-tar products and other substances, of timber-preserving specifications, and of more than 100 references to various authorities upon the topics alluded to in the paper. —*The Mining Journal.*

Rafts on the Rhine.—The tedious, expensive, and cumbrous method of bringing timber down the Rhine in times gone by is thus described :—The extreme breadth allowed for a Rhine timber raft in former days was 90 feet, and the greatest length 1,000 feet, or just 333 yards. Rafts of this size required a crew of between 400 and 500 men to steer and manage them, among the constant dangers and currents of the wide and winding Rhine, whose breast of waters broadly swells, says the poet ; that is to say, whose depth and currents scarce ever allow the water to get smooth, but swirl it along in violent eddies, in which it seems to plait itself like the wealthy hair of the deep-blue-eyed peasant girls with whom the imagination of the same poet peopled its banks. The chief causes of the tumultuous flow of the Rhine stream are, of course, its swiftness and its mighty mass of water ; but others are the extraordinary variations of its fall and of the breadth and depth of its bed. The depth varies from 9 to 76 feet between Mainz and Bonn, reaching its greatest at the sharp turn round the 433 feet high Lurlei cliff. Between Bonn and Cologne, again, the soundings range from 10 to 30 feet, and thence to Düsseldorf they change from 12 to 66 feet.

The palmy days of the Rhine timber industry are past. In the first place, the supply of wood is not what it was ; and then vast quantities of it which were formerly floated down the river at one season of the year are now dispersed in all directions daily by the railways. Besides, the enormous modern development of foreign trade and shipping brings better and cheaper timber from far distances. Thus, although one of the chief occupations of Dordrecht—the terminus time out of mind of the raft voyages—still consists in timber, we must go back into the past to describe the monstrous constructions which were put together opposite the little raft-building village of Namedy, below Andernach. There were even to be found eclectic Rhine-tramps who took pleasure-trips on these rafts a hundred years ago. We may look upon an excursion in a canal boat as the very flattest form of outing ; but beneath this lowest deep there was a deeper still—the Rhine-raft of timber logs.

The moderate sized floats of timber, some of which may still be seen in the late summer coming down the Neckar in charge of one or two men, were all steered from Mannheim and Mainz down to Namedy, and when sufficient timber was collected a great raft was made. Its construction began by the making of smaller rafts, which were—but perhaps we had better make use of the historical present and say are—afterwards joined together. The foundation consists partly of pine trees over 70 feet long, and partly of oak. These trees are bound together end to end until the desired length is obtained. Across these more pine trees are next laid, and secured with immense iron spikes. Another longitudinal row follows, and again a cross row, and so on until

a considerable thickness is obtained ; for a complete raft when fully laden draws from 6 to 7 feet. Then came the building of the houses or shanties to serve as stores for provisions during the drifting sluggish voyage of 250 miles, and as cabins for the master, crew, and servants ; and, last of all, the seats for the rowers were placed. The bow of the big raft is formed of several small rafts about 8 feet wide, consisting of a single row of timber, each maintained at some distance from the main raft by one great trunk of oak, so as to give greater flexibility. Athwart the other parts which form the main structure, and under water, run the pine beams and heavy cordage which bind the whole together. There were no fewer than twelve sorts and sizes of ropes and cordage used, nearly all of which had Dutch names. The storage space required for provisions may be judged from the average consumption on a voyage from Namedy to Dordrecht, which was 20 tons of bread, 8 or 9 tons of meat, salt and fresh, the same weight of cheese, 1,500 pounds of butter, 500 to 600 tons of beer, and 7 or 8 fuders of wine, equal to about 2,500 gallons ; besides a vast bulk of dry vegetables. In the kitchen, whose chimney was a hole in the roof, eight cooks relieved each other night and day, and constant fires—the wood for which had also to be carried—were kept up under several large copper boilers. The beer and wine casks necessitated coopers and cellarmen ; and the stable held half a dozen fat oxen, under the charge of two butchers. The lodgings or cabins of the master, mates, and stewards had separate bunks for each man, large tables, chests, and cupboards, and were otherwise furnished like the houses of comfortable peasants.

Two days before the "sailing" of the raft on Holzflosse, the toll-farmers of the electors came on board from Andernach, Leutesdorf, Linz, and Bonn ; measured the depth, length, and breadth ; and, generally after a long and angry contest with the master, were paid their tolls (Flösszölle), which were for the most part quite arbitrary. The farmers were then entertained at a stupendous dinner, mainly consisting of great joints of meat and vegetables, with unlimited Rhine and Moselle wines and even burgundy and champagne ; and the scene, as a matter of course, wound up like a picture of "Dutch boors drinking." Next day the population of the raft had final orders to hold themselves in readiness for embarkation ; and the butchers, bakers, and cooks set to work with a will. When time was up and all the crew were at their posts, the mate made the tour of the whole raft, minutely inspecting both ship and crew. The wages to Dordrecht were fixed at $5\frac{1}{2}$ écus, or about 30*s.* of our present money, exclusive of food. In case of accident or delay the men had to work three days for nothing ; but after that interval had twelve kreutzers daily, or about an English shilling of to-day. The inspection over, the head cook gave the signal for dinner by hoisting a large basket on the end of a long pole, when there a-

rose a general cry of "Ueberall!" (all hands on deck); and the raft's company grouped themselves into messes of seven, each of which sent a deputy to the kitchen for his wooden bowl of pea-soup with bread and cheese. Another journey brought the meat and salt; and a third the beer in the same bowls, first well washed in the Rhine. The anchors were then all weighed; and the pilot, shaking hands with the master, climbed his "bridge" to take command. Removing his hat, he called out "Pray all;" and the crowds, ashore and afloat, uncovered too and joined in prayers for a safe voyage. The pilot's next cry was, "Let go all!" The men in the bows got out their long sweeps, and began to pull like bargees, and the immense structure was free. Behind followed numbers of boats; fifteen or sixteen of the largest, laden with the heaviest of the anchors and ropes, had a crew of seven; others carried rigging and stores of less weight; and the smallest were fishing boats, with a crew of three, which were for going ashore. While the heavy anchors were thus carried in attendant boats, others for immediate use in emergencies found their places on the raft or craft itself; and in all there were some five-score of them, the least of which was about 2 cwt.

The rafts all touched below Cologne at Mulheim, where a day was passed, and at Zous, which then belonged to the chapter of Cologne, the tolls claimed by that body were paid. At Düsseldorf the German pilot gave over charge to a Dutchman. Each of these pilots got 500 florins, or about £45, which would now be worth double that sum, and each had a pilot's mate, who was paid about the same wages. At Düsseldorf too the rafts were again measured, and another toll was taken. While thence to Dordrecht, the journey's end, there were no fewer than thirteen other tolls paid to the chartered robbers of the Rhine. At Dordrecht the raft was "paid off," and the labour of breaking up began and continued for many days.

The value of one of these gigantic rafts a century ago was about 350,000 florins, or £63,000 of our money, and all its wood was rarely sold off in less than two years. Most of it passed through the innumerable wind saw-mills that still surround the town before they found their way into commerce as planks. In modern times the raftsmen have all migrated to Coblenz, Wallersheim, and Neuendorf, where the rafts, which do not carry a third of their old crews, are now put together. A raft proprietor, even of the present day, is said to require a capital equivalent to £45,000, one-third of which should be in standing timber, one-third in floating logs, and the remainder in cash for current charges.

This kind of camping out, with a floating village of refuge, and every landscape a dissolving view, to be replaced by another in due course, must have had something of romance about it for a contemplative mind not concerned with the tolls and the dis-

putes there-anent, which to those interested would be likely to ruffle the kindliest temper.

The lumberers in all countries are an intelligent race of men, who know the value of orderly co-operation or discipline. Each has his place assigned him, and they pull well together.—*Timber Trades Journal.*

LECTURE AT THE FORESTRY EXHIBITION.—Major Bailey, R.E., Superintendent of Forest Surveys in India, and Director of the Indian Forest School, delivered a lecture in the committee-room at the Forestry Exhibition last night, his subject being "Indian Forest Surveys." Dr. Cleghorn occupied the chair. Major Bailey spoke of the necessity that existed for establishing a special board to survey forests, and stated that in India, between 1872 and 1883, there had been surveyed and mapped out a total of 2,835 square miles of forests, the cost of surveying being from 3*d.* to 3½*d.* per acre. The maps were required principally to enable schemes of management or working plans to be prepared, these being necessary to regulate the working of all forests. There were many difficulties in the way of effecting the regeneration of Indian forests. Natural regeneration consisted in the gradual removal of the crop in such a manner as to promote the production of seed. Under favourable conditions, such as existed in France, that was comparatively easy; but it was not so in India, the work being rendered very difficult in consequence of the protracted droughts; nor could artificial regeneration be always successfuly carried out. Another great difficulty with which they had to contend was the want of markets for the produce of the Indian forests. The prices for what were now considered inferior kinds of wood were so small that they would not pay the cost of conveying the timber to market, and in one district about 60 per cent. of the wood was allowed to lie and cumber the ground, preventing the seedlings coming up, and increasing the risks from fire. Forest fires were among the greatest enemies of the Indian forester, and to cope with them "fire lines," measuring in some cases 200 feet in breadth, were cut through the forest so as to secure the isolation of the flames. A good deal of damage was caused to the forests in India by the grazing of camels, cattle, sheep, and goats, and it was found to be very difficult to deal with them. The goats were the most destructive, and ought, in the lecturer's opinion, to be excluded from all forests. Major Bailey went on to speak of the removal of timber by Government agency, or by the selling of the standing trees, and pointed out the difficulties of exporting timber from the Himalayan forests. He concluded by recommending the preparation of working plans for all Scottish forests. The lecturer was, at the close, awarded a hearty vote of thanks.—*Scotsman.*

FORESTS IN ORISSA.—The following extract from a resolution of the Government of Bengal on the management of the Tributary States of Orissa, will interest our readers :—

"With regard to forest conservancy, the Superintendent remarks : —'The Tributary Mehals are without doubt among the best timber-producing tracts in India, but unfortunately the Native Chiefs, by whom a greater portion of it is owned, have hitherto taken little care of their forests. They have established no reserves, and the forests are recklessly wasted without any corresponding gain to agriculture or to the general wealth or prosperity of the country.' The advice given to the Chiefs on this subject appears from the first to have been totally ignored by them. As the country is opened up, and the timber becomes more valuable, the Chiefs will no doubt be induced, in view of their own interests, to preserve the forests. In the meantime, the Superintendent can do no more than impress on them the future advantage they will gain by preservation. No officer could be *spared from the Forest Department of this Government, or of the* North-Western Provinces, during the past cold season, to examine and advise the formation of reserves in the forests of Dhenkenal and Mohurbhunj, as the late Superintendent had suggested. The Lieutenant-Governor will, however, endeavour to procure the services of an officer for the purpose during the ensuing cold season. The Khondmal forests were, it is stated, examined during the year by the Conservator and Deputy Conservator, and considered to be valuable. No report or recommendations regarding them have, however, as yet been received by this Government. The Superintendent considers that it would, in a political point of view, be a very dangerous experiment to insist on the formal reservation of these forests, and that whatever is done should be done gradually and with the consent of the Khonds themselves. As the Superintendent expresses his intention of visiting this part of the country next cold weather, and taking some steps towards an indirect forest conservancy, the Lieutenant-Governor will await his report before passing further orders on the subject. The reserved forests in Angul were brought by a Government notification of the 6th December, under section 19 of the Indian Forest Act. The reserves notified have not yet been accurately surveyed, but the total area is reported approximately at 170,880 acres. The reserves in Angul are not at present worked, and are to be allowed rest for 10 or 12 years. It is satisfactory to note that, as regards Angul, the demarcation of boundaries has been practically completed."

FORESTS OF CHOTA NAGPORE.*—"The attitude of the local zemindars has rendered it impossible to take any action for the preservation of private forests under the rules framed by the Commissioner and Conservator last year. The matter will be again taken up, in the camping season, when the Inspector-General of Forests will visit Chota Nagpore with the Conservator, in order to confer with the Commissioner on the spot. It is hoped that Mr. Hewitt's influence

* Extract from Resolution of Government of Bengal on the administration report of the Chota Nagpore Division 1883-84.—[ED.]

will be able to overcome the ignorance and indifference of the proprietors, and to persuade them that the introduction of a system of conservancy, under the supervision of the Forest Department will secure to them a permanent income from property which is now being rapidly destroyed. The necessity of taking early measures to protect the private forests of Chota Nagpore, is strongly accentuated by the action already taken for railway construction in many parts of the division, and the importance of the subject is clearly brought out by the following extract from the Commissioner's report :—

"'What between jhúm cultivation, the destruction of young trees by goats and cattle, the enormous consumption and destruction of timber in these countries, where every one builds his house of young trees, placed close together, fences in his garden with young trees, and cuts large numbers to burn for manure on his upland cultivation ; the new settlement of a hilly tract means the denudation of the hills in a few years, and this denudation must largely increase before very long, when railways will make traffic in timber more profitable than it is at present. The denudation of the hills is followed by the soil being washed away by rain, and the hills changed from valuable forests into bare rock, while the river-beds must be filled up by the denuded earth and gravel, and the rainfall decreased by the loss of the trees."

DR. SCHLICH, Inspector-General of Forests, under the Government of India, goes home in February to organise a forest class at Cooper's Hill College. The work will probably keep Dr. Schlich in England for a year or two, during which time Mr. Ribbentrop, Conservator of Forests in the Punjab, will act for him.

WE regret to have to announce the death of Mr. H. H. Yarde, who retired from the Forest Department, on a pension, about two years ago.

Mr. Yarde was for many years in charge of the Cuddapah Forests, living at Kodur, where his work in propagating red sanders has proved so valuable.

WE have received a copy of the Souvenir of the Edinburgh Forestry Exhibition, which is extremely well got up, and gives a complete account of the exhibits ; the price, one shilling, is very reasonable.

WOOD PAVEMENTS.—There is but one verdict rendered by experience, and that is in favour of the wood pavement, laid down according to the improved methods now in use. Macadam is no longer thought of for streets destined to stand the wear and tear of heavy travel. Asphalte affords so poor a footing that even the horses learn to fear and avoid it ; while the stench given

out by foul matter which penetrates and fills its pores is both offensive and disease-breeding. Stone pavements are a very nightmare to those who have been forced to endure their ceaseless racket. Most costly in the first instance, as dangerously slippery as asphalte and productive of more serious results in cases of a fall, penetrable by water and filth, an agony to those who ride over them, and destructive alike to inorganic matter and to human nerves, they are in most respects the worst investment that a city could possibly make. Wood, laid down according to the methods here accurately described, is the nearest approach to the ideal pavement, and in its favour the great cities of London and Paris are discarding all other materials. Wooden blocks are placed upon a solid foundation of concrete, a quantity of bitumen or asphalte is poured into the interstices, and these are then filled to the surface with cement. The whole makes a magnificent roadway, durable, impenetrable by water, elastic, non-resonant, as nearly perfect as human ingenuity has been able to devise. This is the pavement which, with all its other advantages, is practically indestructible, and which ought to be put down in the great cities of the North-west and the world. It is the cheapest in the long run; and, with such a system as is described for paying the cost of laying and of maintenance, it ought not to prove a burden to any progressive community.—*St. Paul Pioneer Press.*